Handwashing:
Population-Tailored Promotion and the Problem of Self-Reporting

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Nadja Contzen

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Prof. Dr. Hans-Joachim Mosler (main advisor) and

Prof. Dr. Urte Scholz

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Abstract

Each year, around 2 million children younger than five years die due to acute respiratory infections and diarrhoeal diseases. The two diseases are not only the global leading causes of under-five mortality but also major killers in humanitarian disasters. Handwashing with soap at key times is the best preventive measure against diarrheal diseases and an effective barrier to acute respiratory infections. In developing countries, where the death tolls are highest, regular handwashing is rarely habitual. Accordingly, promotion of handwashing should be a priority in development and emergency programs. There is a need and a demand for effective handwashing interventions but rigorous evaluations of handwashing interventions in development and emergency aid are scarce. Evaluation of handwashing interventions are challenging due to the lack of a valid behaviour measure which is at the same time efficiently collected. Consequently, the effectiveness of regularly applied handwashing interventions is uncertain and evidence-based programming an exception. Behaviour change interventions are assumed to be especially effective when they are theory-based, i.e. when they address and thus modify the social-cognitive determinants of a behaviour and consequently change the behaviour itself. As each theory is restricted to a set of potential determinants and thus might miss crucial change processes for behaviour adoption, a multi-theoretical approach to intervention development is seen as even more promising. In addition, effectiveness is expected to further increase, when an intervention is matched to the target population's needs. To contribute to the search for effective handwashing interventions in development and emergency aid, the present thesis aims (1) to evaluate handwashing interventions in emergency aid; (2) to investigate the potential of theory- and evidence-based population-tailored interventions compared to standard approaches in development and emergency aid; and (3) to explore a major challenge to handwashing intervention evaluations, that is over-reporting in self-reported handwashing behaviour.

The thesis followed the RANAS approach, a multi-theoretical framework providing a method to tailor an intervention's content to the behaviour determinants in a target population. Three surveys were conducted. Survey 1 (N = 811) was a cross-sectional survey situated in the metropolitan area of Port-au-Prince and in rural areas in the West Department of Haiti. Surveys 2 (N = 463) and 3 (N = 554), both cross-sectional, were conducted in four rural kebeles in the Borena zone of southern Ethiopia. Together, the two surveys provide longitudinal data. All surveys assessed social-cognitive factors and handwashing behaviour. In addition, survey three measured factors potentially explaining over-reported handwashing.

Structured face-to-face interviews were applied in all surveys; surveys 2 and 3 additionally employed handwashing observations. The data gained by the surveys delivered the basis for the six empirical studies constituting this thesis. The social-cognitive determinants of handwashing in Haiti and in Ethiopia were cross-sectionally explored in studies 1 and 2 by means of multiple regression analyses. Study 3 evaluated handwashing interventions conducted in Haiti in response to the earthquake in January 2010 and the cholera outbreak in October 2010 by means of a cross-sectional, correlative design and mediation analyses. Two theory- and evidence-based population-tailored interventions were developed in study 4 according to the results on the social-cognitive determinants of handwashing in the four Borena kebeles in southern Ethiopia. These were tested in a nonrandomised controlled trial in the four kebeles in a full factorial design in combination and comparison to a standard approach, an education intervention. Cross-sectional and longitudinal data were applied. Study 5 tested whether, the applied interventions changed handwashing behaviour indeed by changing specific social-cognitive determinants by means of mediation analyses of longitudinal data. Factors explaining over-reported handwashing and alternative measures to reduce over-reporting were investigated in study 6 applying cross-sectional data and correlative and experimental designs.

Results in study 1 and 2 indicated that in Haiti and Ethiopia high self-reported handwashing behaviour was primarily explained by high descriptive norms (i.e. expectancy that others often wash their hands), high injunctive norms (i.e. perception that others expect one to wash one's hands), high motivational self-efficacy (i.e. high confidence in one's ability to regularly wash one's hands), low impediments (i.e. feeling seldom hindered in handwashing), high coping plans (having plans how to cope with impediments), high commitment strength (i.e. feeling highly committed to handwashing) and low forgetting (i.e. rarely to forget to wash one's hands). Therefore, in study 4 two interventions were developed to increase social norms, motivational self-efficacy and commitment, and to mitigate impediments and forgetting. These were (1) a public-commitment intervention comprising public commitment and a reminder (a headscarf), and (2) an infrastructure-promotion intervention comprising facilitating resources (i.e. construction of handwashing stations) and a reminder (the handwashing station). The two interventions, combined with a standard education intervention, changed behaviour more successfully than a standard education intervention alone. Moreover, in study 5 the social-cognitive factors were found to mediate the interventions' effects on behaviour change. With regard to standard interventions in emergency aid, study 3 revealed that activities and channels applied during the emergency response in Haiti were partly positively associated with handwashing behaviour, partly unassociated with handwashing behaviour, while others, surprisingly, were even negatively associated with behaviour. These results indicated that potentially effective, potentially ineffective and potentially counter-effective intervention approaches had been applied. Study 6 revealed factors explaining over-reported handwashing beyond socially desirable responding, i.e. factors involved in encoding and recall. While no clear suggestions for alternative self-report measures were provided, it is indicated that measures are in demand, which mitigate social desirability, encoding and recall errors in parallel.

The results of this thesis emphasise the relevance of social-cognitive theories to explain behaviour and to increase the effectiveness of behaviour change interventions. With regard to the promotion of handwashing interventions that tackle social norms, motivational self-efficacy, impediments, commitment and forgetting seem promising. In addition, the thesis further highlights the indispensability of intervention evaluations in development and emergency aid. Only therewith can the use of ineffective or even counter-effective interventions be avoided. Hopefully, this thesis may encourage practitioners in development and emergency aid to integrate theory and evidence into practice and therewith contribute to increasing the effectiveness of handwashing interventions to fight childhood mortality.

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List of abbreviations

APA	American Psychological Association
BCT	Behaviour Change Technique
DALYs	Disability Adjusted Life Years
DEA	Development and Emergency Aid
E. coli	Escherichia coli
FRH	Food-Related Handwashing
HAPA	Health Action Process Approach
HBM	Health Belief Model
MPMHD	Model of Prospective Memory and Habit Development
MO	Multilateral Organisation
INGO	International Non-Governmental Organisation
NGO	Non-Governmental Organisation
OvR	Over-Reporting
PHAST	Participatory Hygiene And Sanitation Transformation
PMT	Protection Motivation Theory
RANAS	Risk, Attitudes, Norms, Ability, Self-regulation
SCM	Social Cognition Model
SCT	Social Cognitive Theory
SDR	Socially Desirable Responding
SRH	Stool-Related Handwashing
TRA	Theory of Reasoned Action
TPB	Theory of Planned Behaviour
TTM	Transtheoretical Model
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation

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Part One

General introduction and overview

1. Handwashing – a vaccine against childhood infections

In 2012, 6.6 million children died before reaching the age of five years (You, Bastian, Wu, & Wardlaw, 2013). Only two diseases together accounted for around 30% of these deaths, acute respiratory infections and diarrheal diseases (1.3 million and 700,000 in 2011; Walker et al., 2013). The two diseases are not only the global leading causes of under-five mortality but also major killers in humanitarian disasters – due to inadequate water and sanitation facilities, crowded living conditions or disruption of familiar and healthy practices (Wisner & Adams, 2002). Moreover, diarrheal disease is interlinked with child malnutrition: the disease is not only particularly lethal in malnourished children, it is also a major cause of malnutrition, which makes children more vulnerable to other diseases (Bartram & Cairncross, 2010; Dangour et al., 2013). Acute respiratory infections and diarrheal diseases rank globally in the top four causes of disability adjusted life years (DALYs), defined as years of life lost through premature death and years of life lived in less than optimal health (Mathers & Stevens, 2013; Murray et al., 2012). For both diseases, death and disease burden is highest in developing countries, especially in Sub-Saharan Africa (Black et al., 2010; Murray et al., 2012; You et al., 2013).

Diarrheal diseases, including cholera, are mainly caused by faecal-oral contamination; that is, pathogens from the faeces of one person are ingested by another (Curtis, Cairncross, & Yonli, 2000). Pathogens can spread via multiple transmission routes, including water, soil, flies, food and fingers (Waddington, Snilstveit, White, & Fewtrell, 2009). While improvements in water, sanitation and hygiene (WASH) can break the transmission routes, systematic reviews revealed that one of the simplest and cheapest preventive measures is also the most effective: handwashing with soap at key times reduces diarrheal diseases up to 48% (Cairncross et al., 2010a; Ejemot, Ehiri, Meremikwu, & Critchley, 2008; Fewtrell et al., 2005). The key times for handwashing[1] are after defecation, after handling child faeces or cleaning a child's anus after defecation, before preparing food, before feeding a child and before eating. Of these, to lower diarrheal disease in children under the age of 5 years, especially crucial are a caregiver's handwashing after her/his defecation and before she/he prepares food (Luby, Halder, Huda, & Johnston, 2011). Further, there is evidence that improvements in water and sanitation may be futile without improvements in hand hygiene. First, hands are co-responsible for (re-)contaminating safe or treated drinking water (Wright, Gundry, & Conroy, 2004). Second, improved sanitation in schools (or other public buildings)

[1] In the following, handwashing stands for handwashing with soap.

without a parallel increase in handwashing, may lead to a higher risk of spreading Escherichia coli (E. coli) at schools. Due to improved sanitation pupils more frequently defecate at school (instead of at home) than before. Without improved handwashing, pupils' hands are thus more often contaminated with E. coli during school and spreading at schools increases (Greene et al., 2012).

Handwashing also reduces malnutrition; not only indirectly through lower diarrhoea rates but also directly: there is growing evidence that indicates that tropical enteropathy caused by faecal bacteria is a major cause of malnutrition; and the best protection against faecal bacteria is safe faeces disposal and handwashing after contact with faeces (Dangour et al., 2013; Humphrey, 2009).

Respiratory pathogens are transmitted through air, droplets and direct-contact but also via hands and faecal-oral (Rabie & Curtis, 2006). Accordingly, improved hand hygiene, especially after blowing the nose, coughing or sneezing, is also an effective preventive measure against acute respiratory infections, including pandemics: systematic reviews revealed disease reductions of 16-21% (Aiello, Coulborn, Perez, & Larson, 2008; Rabie & Curtis, 2006). While these reviews include mainly studies from developed country, a randomised controlled trial in Pakistan found disease reductions of 50% in children younger than five years (Luby et al., 2005).

Altogether, it is estimated that improved hand hygiene could save one million lives a year by reducing diarrheal disease, acute respiratory infections and further communicable diseases (e.g. health-care associated infections), while costing only 3US$ per DALY prevented (Biran et al., 2012). In sharp contrast to this immense health-promoting potential stands the actual hand hygiene of primary caregivers in developing countries. A review of structured observations in 11 developing countries found that primary caregivers washed their hands only 17% of the times after using the toilet and only 13% of the times before preparing food (Curtis, Danquah, & Aunger, 2009). Promoting domestic handwashing should be a program priority in development and emergency aid (DEA; e.g. Odhiambo & Reed, 2013; United Nations Children's Fund, 2008). Effective interventions that change handwashing behaviour sustainably are in great demand.[2] In the following, the evidence-base for

[2] In developed countries, although higher, handwashing compliance is also insufficient (e.g. Anderson, Shuster, Hansen, Levy, & Volk, 2004) and thus remains also a challenge, especially in healthcare settings and during pandemics (e.g. Bittner, Rich, Turner, & Arnold Jr, 2002; Updegraff, Emanuel, Gallagher, & Steinman, 2011). Nevertheless, the remaining of this thesis will focus on domestic handwashing in developing countries.

handwashing interventions in DEA is discussed and implications for the present thesis are derived.

2. Handwashing interventions in DEA: State of affairs and way to go

2.1. Practitioners' approaches: A lack of evidence

Many of today's handwashing interventions by aid agencies go back to activities and tools developed for the Participatory Hygiene and Sanitation Transformation (PHAST), a participatory methodology specifically developed for the WASH sector (The World Bank, n.d.; WaterAid, 2013). The main idea of the PHAST is to improve hygiene and sanitation in a participatory way so that communities discover for themselves the faecal-oral route of contamination, analyse their own hygiene behaviours in the light of this information and plan how to block the contamination routes (Simpson-Hebert, Sawyer, & Clarke, 1997). For that, the PHAST developed group activities and tools aiming at mutual learning of the communities' health risks and their according preventive measures. They include mainly picture cards depicting hygiene relevant situations that have to be adapted to the local context. Similar activities and tools were developed by the Global WASH cluster, a consortium of multilateral organisations (MOs) and international non-governmental organisations (INGOs) working in WASH (Global WASH Cluster, 2011). The cluster developed a manual to ensure a more consistent approach in their cluster-members' hygiene promotions and produced a visual aids library (Global WASH Cluster, 2009b, 2011). The library provides ready to use tools for the early stages of an acute emergency (i.e. emergency relief), where there is limited time to develop promotion tools. Further, promotion tools and communication methods for emergencies were also specified by the World Health Organisation (WHO; Odhiambo & Reed, 2013). Table 1 provides an overview of the communication channels, activities and tools that were proposed for handwashing interventions by the PHAST (Simpson-Hebert et al., 1997), the Global WASH Cluster (2009b, 2011) and the WHO (Odhiambo & Reed, 2013). Table 1 also depicts the implied behaviour change techniques (BCTs), i.e. the "observable, replicable, and irreducible component[s]" of the activities and tools designed to change behaviour (Michie et al., 2013, p. 82). BCTs were assigned to activities and tools according to a taxonomy proposed by Abraham (2012). The taxonomy resulted from a recent attempt in health psychology to facilitate evidence-based practice in behaviour change interventions, i.e. the use of techniques, which were proven effective in previous interventions. The basic but crucial assumption is that evidence-based practice is only possible when a classification of standardised, reliable definitions of intervention techniques is established and also used in intervention descriptions; only the use of such a classification system allows to systematically replicate effective interventions (Abraham & Michie, 2008). Therefore, Abraham's taxonomy was applied for the present purpose. It consists of 40 different techniques. One of the BCTs implied by the activities and tools proposed by the PHAST (Simpson-Hebert et al., 1997), the Global WASH Cluster (2009b, 2011) and the WHO (Odhiambo & Reed, 2013) has not been considered in the taxonomy and was thus added, namely provision of facilitating resources (cf. Mosler, 2012).

When looking at the implied BCTs it becomes apparent that only a small number of different techniques have been proposed (i.e. eight) and that the activities focus largely on information-provision and awareness-raising, namely to provide information about behaviour-health links (BCT-1), information about likely material consequences of behaviour, usually focusing on health consequences (BTC-2), and instructions (BCT-16; see Table 1; the BCT-numbers here and in the following are according to Abraham, 2012). In addition, during emergencies the provision of resources (e.g. soap and water buckets) is also a highly recommended technique (The Sphere Project, 2011; Vujcic, Blum, & Ram, 2014). Additionally proposed behaviour change techniques are to provide cues or reminders (BCT-37), demonstration of behaviour (BCT-18), prompt behaviour practice (BCT-20), and prompt barrier identification and planning in relation to anticipated barriers (BCT-21).

For practitioners the activities and tools proposed by the PHAST (Simpson-Hebert et al., 1997), the Global WASH Cluster (2009b, 2011) and the WHO (Odhiambo & Reed, 2013) together with intuition, previous experience and best practice build often the basis for developing handwashing interventions (A. Andres, Oxfam Great Britain, personal communication, June 25, 2014; Vujcic et al., 2014). This is alarming in a threefold way. First, intuition is important but might lead practitioners away from systematic assessment. Second, rigorous evaluations of aid agencies' handwashing interventions are the exception, especially in emergency settings (Aboud & Singla, 2012; J. Brown, Cavill, Cumming, & Jeandron, 2012; Parkinson, 2009; Vujcic et al., 2014). That is, "best practice" is often solely based on anecdotal evidence (Vujcic et al., 2014). Third, to date the effectiveness of the proposed activities and tools has never been demonstrated (Peal, Evans, & van der Voorden, 2010; The World Bank, n.d.). Altogether, this is in contrast with the often stated notion to apply evidence-based interventions to increase program effectiveness, that is interventions for which rigorous evidence of their effectiveness to change behaviour and therewith health outcomes is available (e.g. Davidson et al., 2003; Michie & Abraham, 2004).

Table 1. Communication channels and activities for DEA proposed by the PHAST, the Global WASH cluster and the WHO

Comm. channels	Promotion channels/activities	Implied BCTs
Interpersonal communication/activities		
Information focused	Home visits/One-to-one discussions	Information; Consequences Instruction; Resources; Demonstration; Practice
	Focus group discussion/community discussions	Barrier/Planning
	Group session with demonstration	Information; Consequences Instruction; Resources; Demonstration; Practice
	Group activities (adults), e.g. f-diagram exercise, three-pile sorting	Information; Consequences Instruction
Entertainment focused	Games and tournaments (children)	Information; Consequences; Practice
	Hygiene songs	Information; Instruction; Cues
Mass communication: audio-visual		
Information focused	Radio spots, radio shows, megaphones	Information; Consequences Instruction
Entertainment focused	Soap operas, theatres and puppet shows	Information; Consequences Instruction; Demonstration
	Cinemas and slide shows	Information Consequences Instruction; Demonstration
Mass communication: written		
	Posters	Information; Consequences Instruction; Cues
	Leaflets	Information; Consequences, Instruction
	Stickers	Information; Consequences; Cues
	Paintings	Information; Consequences; Instruction; Cues

Note. BCTs [numbering according to Abraham, 2012]: Barrier/Planning = Prompt barrier identification and planning in relation to anticipated barriers [BCT-21]; Consequences = Describe or generate knowledge about likely material consequences of behaviour [BCT-2]; Cues = Provide cues/reminders [BCT-37]; Demonstration Model/demonstrate the behaviour [BCT-18]; Information = Provide general information or generate knowledge on behaviour-health links [BCT-1]; Instruction = Provide instruction [BCT-16]; Resources = Provide facilitating resources; Practice Prompt behavioural practice [BCT-20]. Sources: Global WASH Cluster (2011); Odhiambo and Reed (2013); Simpson-Hebert et al. (1997); The Sphere Project (2011).

2.2. Handwashing intervention research: The evidence-base

The existing evidence-base for handwashing interventions in developing countries stems primarily from academic research. Table 2 gives a summary of previous handwashing intervention research (i.e. 24 articles reporting 22 unique studies). The studies were selected based on a systematic review (Cairncross et al., 2010a) and two qualitative reviews (Briscoe & Aboud, 2012; Vindigni, Riley, & Jhung, 2011) and complemented with recently published handwashing intervention studies. Only studies meeting the following four criteria were included: (1) intervention in a developing country focusing on domestic handwashing; (2) providing a quantitative outcome; (3) applying a comparison group or a pre-post design; (4) providing a description of the intervention content. Intervention content was again categorized to BCTs according to Abraham (2012). A second BCT had to be added to the list, namely public commitment or pledging (cf. Mosler, 2012; see also Michie et al., 2013).

Of the 24 articles, the majority (71%) reported successful changes in handwashing behaviour. Five articles provided mixed results and only two stated no behaviour change. While this positive result might be partly caused by publication bias (i.e. studies with positive outcomes are more likely to be published), it still provides evidence that handwashing behaviour can be changed effectively by behaviour change interventions.

With regard to BCTs, in the investigated studies 12 different techniques had been applied. In addition to the eight BCTs that have been proposed for DEA (see above), the studies applied the following BCTs: provide information about others' behaviour or provide role models (BCT-9); prompt the organisation of social support (BCT-36); provide contingent rewards (BCT-39); and public commitment. The most frequently applied BCTs were the same as in the activities proposed for DEA: provide general information on behaviour health links (BCT-1), which was used in 19 of the studies and provide instructions (BCT-16), which was applied in 16 studies. To provide material (10 studies) and to describe likely material consequences of behaviour (7 studies, BCT-2) were also applied in multiple studies. For the latter, while it mainly focused on health consequences (paralleling the above recommendations for DEA), two studies applied rather innovative approaches by targeting disgust (i.e. to avoid dirt; Scott, Schmidt, Aunger, Garbrah-Aidoo, & Animashaun, 2008) and disgust and nurture (i.e. to raise a happy, thriving child; Biran et al., 2014). The remaining eight BCTs were applied in only one or two of the studies each.

Table 2. Overview on handwashing intervention studies in developing countries

			Time frame				
Authors	BCTs	Channels	Intervention	Evaluation	Outcomes	Effectiveness	
Abu Mourad (2006)	Information Instruction	Group meetings Home visits	Over 1 year	n.n.	Intestinal parasites Diarrhoea Self-reports	Reduction in intestinal parasites No reduction in diarrhoea Increase in handwashing	+/-
Arnold et al. (2009)	Information Instruction	Home visits	Monthly or bi-monthly for half an hour over 3 years	Six months after	Diarrhoea Pneumonia Child growth Self-reports Spot-checks	No increase in handwashing No increase in presence of soap and water No reduction in diarrhoea, No reduction in pneumonia No effect on child growth	-
Biran et al. (2014)	Consequences Instruction Cues Others/Models Pledging	Community events School events Group meetings Home visits Song/Posters/Stickers	25 days (long) or 9 days (short)	Six weeks, six months and twelve months after	Observation	Increase in handwashing	+
Biran et al. (2009)	Information Instruction Practice	School events Songs/Stories/Games Group meetings Community event	4 times over a period of 8 weeks	Six weeks after	Observation Motion detector	Increase in knowledge Increase in overall soap use No increase in handwashing	+/-
Brier et al. (2012)	Information Resources (1x soap)	Group meetings Face-to-face Pictorial material	Over 12 months	n.n.	Presence of soap Handwashing demonstration	Increases in presence of soap Better handwashing techniques	+

(continued)

Table 2 (continued). Overview on handwashing intervention studies in developing countries

			Time frame				
Authors	BCTs	Channels	Intervention	Evaluation	Outcomes	Effectiveness	
Curtis et al. (2001)	Consequences Instruction	Home visits Group meetings Street theatre Local radio spots and programmes Hygiene curriculum in schools	3 years	While project was running	Observation	Increase in handwashing	+
Haggerty et al. (1994)	Information Instruction	Home visits Group meetings Songs/Stories/Drawing	Over 0.5 year	While project was running	Observation Diarrhoea	Reduction in diarrhoea	+
Han & Hlaing (1989)	Information Instruction Resources (regularly soap)	Home visits	Biweekly surprise visits over 4 months	Daily surveillance over four months	Diarrhoea Dysentery incidences	Reduction in diarrhoea Reduction in dysentery incidence	+
Hoque et al. (1996)	Information Instruction Resources (hand pumps and latrines)	Home visits Group meetings	5-6 years	5 years after	Diarrhoea Knowledge Handwash samples (tested for E. coli)	Significant reduction in diarrhoea No difference in knowledge Decrease in bacterial contamination	+
Huda et al. (2012)	Information Instruction	Home visits Group meetings Community events (fairs/village theatre)	18 months (project continued)	While project was running Monthly data on diarrhoea and pneumonia	Observations Spot-checks Diarrhoea Pneumonia	Increase in handwashing No reduction in diarrhoea No reduction in pneumonia	+/-

(continued)

Table 2 (continued). Overview on handwashing intervention studies in developing countries

			Time frame				
Authors	BCTs	Channels	Intervention	Evaluation	Outcomes	Effectiveness	
Jagals et al. (2004)	Information Instruction	Group meetings	4 sessions over 8 months	After project completion	Self-reports	No increase in handwashing	-
Khan (1982)	Information Instruction Resources (regularly soap and water pitchers)	Home visits	10 days with daily visits	10 days with daily 2h observations and monitoring	Diarrhoea Shigella	Reduction in diarrhoea Reduction in diarrhoea; shigella	+
Luby et al. (2005)	Information Consequences Resources (regularly soap)	Group meetings (slide shows/videos/ leaflets) Home visits	At least once a week for 1 year	Once weekly for one year	Pneumonia Diarrhoea Impetigo	Reduction in pneumonia Reduction in diarrhoea Reduction in impetigo	+
Luby et al (2009)	Analogous to Luby et al. (2005)	Analogous to Luby et al. (2005)	Analogous to Luby et al. (2005)	18 months after	Soap purchase Diarrhoea Soap and water presence Handwashing demonstration	No difference in soap purchase No reduction in diarrhoea Increases in presence of soap and water Better handwashing techniques	+/-
Luby et al. (2010)	Information Instruction Resources (regularly soap or sanitizer) Demonstration Cues Social support Rewards	Home visits Group meetings Posters/Stickers	2-3 times per week (timeframe not specified)	After project completion	Observation Handwash samples (tested for E. coli)	Increase in handwashing Decrease in bacterial contamination	+

(continued)

Table 2 (continued). Overview on handwashing intervention studies in developing countries

			Time frame				
Authors	BCTs	Channels	Intervention	Evaluation	Outcomes	Effectiveness	
Metwally et al. (2007)	Information Instruction	Home visits Group meetings Community events (puppet shows) Posters/Booklets	Over three years	While project was running and after project completion	Self-reports	Increase in handwashing	+
Pinfold & Horan (1996)	Information Consequences Resources (water containers and soap one time)	Group meetings School events Printed media (Posters/ Stickers/leaflets/ Comics) Songs/Slide shows T-shirts/Badges	n.n.	Weekly diarrheal disease measure and after project completion	Handwash samples (tested for E. coli) Diarrhoea	Decrease in bacterial contamination Reduction in diarrhoea	+
Scott et al. (2008)	Consequences	TV/radio Stickers/Posters/Billboards Community events	Over 6 months	2 months after	Self-reports	Increase in handwashing	+
Shahid et al. (1996)	Information Instruction Resources (water pitchers and regularly soap)	Home visits	Visits on alternate days for one year	Alternate days for one year	Diarrhoea Shigella	Reduction in diarrhoea Reduction in shigella	+
Sircar et al. (1987)	Information Consequences Instruction Resources (regularly soap)	Home visits	Every 3 months over 13 months	Over 13 months	Diarrhoea Dysentery incidences	No reduction in diarrhoea Reduction in dysentery incidences	+/-

(continued)

Table 2 (continued). Overview on handwashing intervention studies in developing countries

			Time frame				
Authors	BCTs	Channel	Intervention	Evaluation	Outcome	Effectiveness	
Stanton et al. (1987)	Information Social support Rewards	Group meetings Home visits Games/Films/Pictorial material	Over 8 weeks several times a week	After intervention over six months	Diarrhoea Observation	Reduction in diarrhoea Increase in handwashing	+
Waterkeyn et al. (2005)	Information Consequences Barrier/Planning	Community health clubs	Over two years and more	When interventions were ongoing	Observation	Increase in handwashing	+
J. M. Wilson et al. (1991)	Information Instructions Resources (regularly soap)	Group meetings Home visits	Four months with visits every two weeks	Four months with visits every two weeks	Diarrhoea	Reduction in diarrhoea	+
J. M. Wilson & Chandler (1993)	Analogous to J. M. Wilson et al. (1991)	Analogous to J. M. Wilson et al. (1991)	Analogous to J. M. Wilson et al. (1991)	Two years after	Diarrhoea	Reduction in diarrhoea	+

Note. BCTs [numbering according to Abraham, 2012]: Barrier/Planning = Prompt barrier identification and planning in relation to anticipated barriers [BCT-21]; Consequences = Provide instruction [BCT-16]; Cues = Provide cues/reminders [BCT-37]; Demonstration = Model/demonstrate the behaviour [BCT-18]; Information = Provide general information or generate knowledge on behaviour-health links [BCT-1]; Instruction = Describe or generate knowledge about likely material consequences of behaviour [BCT-2]; Resources = Provide facilitating resources; Others/Role models = Provide information about others' behaviour/provide role models [BCT-9]; Pledging = Public commitment or pledging; Practice = Prompt behavioural practice [BCT-20]; Rewards = Provide contingent rewards [BCT-39]; Social support = Prompt organisation of social support [BCT-36]. n.n. = not named.

Further, it emerges that many interventions had a long duration of up to several years and/or a very high contact frequency of up to several times a week over several months. In addition, in one-third of the interventions, soap was regularly provided to the intervention households. However, aid projects' durations are often short and high contact frequency or regular soap provision (except during emergency relief) are rarely feasible due to time and monetary constraints.

Therefore, interventions are needed that have the potential to trigger a self-sustained (i.e. no soap provision), long-term behaviour change in shorter time with lower contact frequency. It is questionable that interventions focusing on information-provision and awareness-raising (the most frequently applied BCTs to date) may serve this goal: some of the intervention studies revealed that knowledge and awareness about health risks did not necessarily translate into handwashing practice; others showed that the two factors were not essential prerequisites of behaviour change (e.g. Biran et al., 2009; Hoque et al., 1996). This suggests that additional factors might determine changes in handwashing behaviour (cf. Curtis et al., 2009).

2.3. A way forward for handwashing interventions in DEA

It can be expected that interventions are effective when they succeed in changing the factors determining behaviour, as this should cause a subsequent behaviour change. Evidence on factors determining behaviour are accumulated in theories of behaviour change. Therefore, it is expected that theory-based interventions are likely to cause increased behaviour change (e.g. Lippke & Ziegelmann, 2008; Michie, Rothman, & Sheeran, 2007; Painter, Borba, Hynes, Mays, & Glanz, 2008; Rothman, 2004). In line with this, there is evidence for the superiority of theory-based interventions over those lacking a theoretical underpinning (e.g. Taylor, Conner, & Lawton, 2011; Webb, Joseph, Yardley, & Michie, 2010; but see also Prestwich et al., 2013). Accordingly, it is credible that handwashing interventions could change behaviour more effectively when they are based on theory, that is when they not only target knowledge and awareness but additional factors underlying behaviour change (see also Aboud & Singla, 2012). It is worth noting that only two of the previous handwashing interventions summarized in Table 2 were based on theory, namely the studies by Biran and colleagues (2014) applying the Evo-Eco approach to behaviour change (Aunger & Curtis, 2014) and Luby and colleagues (2010) using the transtheoretical model (TTM; Prochaska &

DiClemente, 1983). Interestingly, exactly these two studies applied most of the additional BCTs beyond information-provision and awareness raising.

Further, especially in emergency settings, handwashing interventions rarely take into account the specific local context (Aboud & Singla, 2012; Vujcic et al., 2014). It has been suggested that interventions are more effective when they consider the respective setting and audience (Aboud & Singla, 2012; Bartholomew, Parcel, Kok, Gottlieb, & Fernandez, 2006). For example, a population's culture determines the predominant norms and their importance; the experience of threat during emergencies can influence risk perceptions. Accordingly, handwashing interventions that focus not only on the determinants of a behaviour (i.e. theory-based interventions) but on the key determinants of a behaviour in a *specific* population or context should be even more effective (Mosler, 2012; see also Abraham, 2012; Bartholomew et al., 2006).

To sum up, aid agencies' handwashing interventions could be optimized (1) by building on theories of behaviour change and targeting the determinants of behaviour change; (2) by applying population-tailored interventions, which target a behaviour's determinants in a specific population; and (3) by evaluating the applied interventions so that in the longer term evidence-based practice is possible. This last point is especially true for the emergency context where there is no evidence-base at all (J. Brown et al., 2012; Parkinson, 2009; Vujcic et al., 2014). While it is possible that interventions that are (in-)effective in a development context are the same in an emergency context, it is credible that the specific conditions in an emergency situation influence an intervention's effectiveness. Altogether, the main aims of the present thesis are:

(1) To evaluate handwashing interventions in emergency relief and recovery aid; and

(2) To investigate whether interventions that are based on theory and evidence and are tailored to the target population are more effective in changing handwashing behaviour than standard approaches in DEA.

In the following chapters, three core requirements for the development of theory- and evidence-based population-tailored handwashing interventions are presented: (1) a theoretical framework to explain handwashing behaviour change (theory-base); (2) a method to specify the key determinants to target in a specific population (population-tailoring); and (3) a taxonomy, which links BCTs to specific determinants, which they are known (or thought) to change (theory- and evidence-base). Subsequently, an essential prerequisite of intervention evaluations is discussed, i.e. the measurement of handwashing behaviour. Part One closes by an outline of the thesis' research questions and a short overview of the conducted studies. The principal part of this thesis, the empirical research that was conducted, is presented in Parts Two to Five. A general discussion of the overall findings, including implications for behaviour change theory and research and recommendations for handwashing interventions in DEA, is given in the final Part.

3. A theory-base for handwashing behaviour

A multitude of factors has been related to individual health behaviour. These include factors extrinsic to an individual, such as policy and regulations, climate, available infrastructure, culture or social groups (e.g. Dreibelbis et al., 2013; Sallis, Neville, & Fisher, 2008), and factors intrinsic to an individual, such as demographic variables, personality characteristics and social-cognitive factors (Conner & Norman, 2009a). When planning health behaviour interventions, it has been suggested to focus on social-cognitive factors. First, because behaviour is assumed to be primarily caused by people's *perceptions* of the objective conditions rather than by the objective conditions themselves, and second, because social-cognitive factors are thought to be more open to change than other intrinsic factors (e.g. personality; Conner & Norman, 2009a).

Several social cognition models (SCMs) have been proposed to predict health behaviour. Among the most often applied are the health belief model (HBM; Becker, Maiman, Kirscht, Don, & Drachman, 1977; Rosenstock, 1966), protection motivation theory (PMT; Rippetoe & Rogers, 1987; Rogers, 1975), social cognitive theory (SCT; Bandura, 1977, 2004), theories of reasoned action and planned behaviour (TRA/TPB; Ajzen, 1991; Ajzen & Fishbein, 1980), and the health action process approach (HAPA; Schwarzer, 1992; Schwarzer, 2008). Each of these models could potentially be applied to develop theory-based interventions. However, each theory is restricted to a set of potential determinants and thus might miss a change process, which is crucial for a *specific* problem (Abraham, 2012). Therefore, it has been suggested that interventions, to be most effective, should focus not only on one theory (Aboud & Singla, 2012; Abraham, 2012; Glanz & Bishop, 2010). Instead, several theories should be considered so as to target those determinants, which seem most appropriate for a specific problem, that is for a *specific* behaviour to be changed in a *specific* population (Abraham, 2012; Bartholomew et al., 2006; Lippke & Ziegelmann, 2008; Mosler, 2012).

A suitable point of departure to design handwashing interventions in developing countries is a recent multi-theoretical framework to behaviour change in the WASH sector, the RANAS (Risk, Attitudes, Norms, Ability, Self-regulation) approach (Mosler, 2012). It was conceived to facilitate intervention development in WASH by providing a comprehensive model integrating the social-cognitive factors specified in the above mentioned SCMs along with a taxonomy matching specific BCTs to these factors (Mosler, 2012). Overall, 17 factors are considered, which are grouped into five blocks, risk factors, attitude factors, norm factors, ability factors and self-regulation factors. All these factors together are thought to be potentially involved in behaviour change; that is, they determine an individual's probability to adopt certain behaviour. As such, the RANAS model follows the idea of continuum models of behaviour change (Weinstein, Rothman, & Sutton, 1998). According to the RANAS model, the 17 factors determine not only behaviour but also intentions and habits. Intentions are assumed to be the most proximal determinant of behaviour according to several SCMs such as PMT (Rippetoe & Rogers, 1987) and TRA/TPB (Ajzen, 1991; Ajzen & Fishbein, 1980). Habits have often been equated with previous behaviour or behaviour frequency. However, it has been suggested that habit is more than just behaviour frequency, and that behaviour frequency does not necessarily result in a habit (Verplanken, 2006). Instead, habit is thought to have three key aspects: frequency, automaticity, and contextual stability (Orbell & Verplanken, 2010). As such, habits are learned behavioural responses to situational cues that are enacted automatically with little conscious awareness (Orbell & Verplanken, 2010). Because handwashing is a frequently performed behaviour practiced at specific times or in specific situations, it is expected that it may transform to a habit (cf. Curtis et al., 2009; Devine, Karver, Coombes, Chase, & Hernandez, 2012). Habitual or automatically initiated handwashing may be seen as the ultimate goal of handwashing interventions (cf. Lally & Gardner, 2011).

In the following, the relevance of the 17 social-cognitive factors compiled in the RANAS model with regard to handwashing is reflected and additional factors that might be crucial for handwashing adoption are discussed. If available, evidence from previous research on handwashing determinants in developing but also developed countries is considered. The evidence from developing countries stems primarily from qualitative research in domestic settings; the one from developed countries is mainly from quantitative research in healthcare settings. The chapter closes with the presentation of a causal framework to explain habitual handwashing behaviour.

3.1. Potential determinants of handwashing according to the RANAS model

Risk factors

The RANAS approach's first factor block builds on the assumption that healthy behaviour is (partly) the result of a person's awareness and knowledge about diseases and health risks (Mosler, 2012). In more detail, it is thought that the perceived *vulnerability* to a disease and the perceived *severity* of a disease determine behaviour. Vulnerability or susceptibility stands for the perceived personal risk of contracting a disease (e.g. diarrhoea). Perceived severity represents the personal gravity of the negative effects of a disease (e.g. risk of child death). The two factors are core determinants in the HBM and are thought to constitute threat perception and directly affect behaviour (Rosenstock, 1966). Similarly, in PMT they are responsible for a threat appraisal which influences behaviour through protection motivation (Rogers, 1975). In HAPA, they are considered as behaviour-distal factors, with their influence being mediated through several additional determinants (Schwarzer, 2008). In previous research applying the HBM, PMT and the HAPA the two factors had rather small explanatory power with regard to behavioural intention and health behaviour compared to additional concepts considered in the respective models (Abraham & Sheeran, 2009; Norman, Boer, & Seydel, 2009; Sutton, 2009). With regard to handwashing, formative research in 11 developing countries revealed that fear of diarrhoeal disease was not associated with domestic handwashing, unless during cholera epidemics (Curtis et al., 2009). Similarly, no association was found between perceived vulnerability to and severity of healthcare-associated infections and handwashing compliance in hospitals (Alp et al., 2011). However, in another study perceived risk was associated with having a designated place and facility for handwashing, which is a proxy measure for handwashing (Devine et al., 2012). Research in developed countries revealed that vulnerability and severity are in general not related with handwashing (e.g. Botta, Dunker, Fenson-Hood, Maltarich, & McDonald, 2008; Clayton & Griffith, 2008), although disease anxiety has been found to be relevant regarding pandemic flu (Yardley, Miller, Teasdale, & Little, 2011).

The RANAS model additionally includes *factual knowledge* as a risk factor, that is knowledge about a disease's causes and consequences and its prevention should increase healthy behaviour (Mosler, 2012). SCT considers health knowledge as a precondition for change (Bandura, 2004) and it is also indirectly included in the remaining SCMs through other constructs, such as response efficacy in PMT (Rippetoe & Rogers, 1987). Further, knowledge is considered in theory of triadic influence (Flay, Snyder, & Petraitis, 2009) and also dissonance theory recognizes that behaviour may change due to dissonant knowledge (Festinger, 1962). In terms of handwashing, in developing and developed countries factual knowledge emerged as a weak behavioural predictor (e.g. Alp et al., 2011; Biran et al., 2009; Curtis et al., 2009; Hoque et al., 1996; O'Boyle, Henly, & Larson, 2001), although knowledge may be decisive in women (Judah et al., 2009).

Altogether, risk factors may set the stage for contemplation about behaviour change and might thus be considered in handwashing interventions.

Attitude factors

Prevention from disease is only one benefit of healthy behaviour that may prompt behaviour adoption. Additional *instrumental* and also *affective beliefs* are thought to bring people to change behaviour (Mosler, 2012; regarding the distinction between affective and instrumental or cognitive-evaluative components of attitudes, see Breckler & Wiggins, 1989; Eagly, Mladinic, & Otto, 1994). Instrumental beliefs are the perceived costs and benefits of a behaviour. Costs may refer to the money (e.g. soap expenditure), time (e.g. walking distance to the next handwashing facility) and effort (e.g. increased water amount to fetch) implied in behaviour performance. Benefits may concern health outcomes (e.g. prevention from diarrhoea), status improvements (e.g. modern people wash hands) or savings (reduced drug expenditure). Affective beliefs are feelings related to thinking about or performing certain behaviour, such as joy when washing hands, or neglecting a behaviour, such as disgust when not washing hands. A behaviour adoption is only likely when benefits and positive affects outweigh costs and negative affects.

Attitude factors are core concepts in TRA/TPB (Ajzen, 1991; Ajzen & Fishbein, 1980). According to the two theories, behavioural beliefs cause attitudes, which affect behaviour through intentions (regarding difficulties in the distinction between behavioural beliefs and attitudes see Schwarzer, 1992). They are also important determinants in SCT: the paralleling concept of outcome expectations (i.e. physical outcomes) is thought to influence behaviour directly and indirectly through goal formation (Bandura, 2004). Further, they are also considered in the HBM as direct behaviour determinants (Rosenstock, 1966), and are conceptualised as having an indirect influence in PMT (i.e. response efficacy, response costs and intrinsic and extrinsic rewards of a maladaptive behaviour; Rippetoe & Rogers, 1987) and the HAPA (i.e. outcome expectations; Schwarzer, 2008). In studies applying these SCMs, attitudinal factors and related constructs emerged as medium to strong predictors of behavioural intention and health behaviour (Abraham & Sheeran, 2009; Conner & Sparks, 2009; Luszczynska & Schwarzer, 2009; Norman et al., 2009; Sutton, 2009).

Regarding handwashing in developing and developed countries results are mixed: some research revealed attitudes as key determinants of intentions or behaviour (e.g. Clayton & Griffith, 2008; Jenner et al., 2006; McLaws, Maharlouei, Yousefi, & Askarian, 2012; Whitby, McLaws, & Ross, 2006; Yardley et al., 2011), while their predictive power is small in other studies (e.g. Alp et al., 2011; O'Boyle et al., 2001; Pessoa-Silva et al., 2005; Sax, Uçkay, Richet, Allegranzi, & Pittet, 2007). However, specific attitudinal factors emerged as key determinants of domestic handwashing in developing countries, namely nurture and disgust, the latter related to handwashing neglect (Aunger et al., 2010; Curtis et al., 2009). Disgust seems also relevant in developed countries (Botta et al., 2008; Judah et al., 2009; Porzig-Drummond, Stevenson, Case, & Oaten, 2009).

To sum up, the pros and cons of a behaviour's consequences including emotional reactions can be seen as essential (de-)motivators to behaviour change and may thus be important targets in handwashing interventions.

Norm factors

Often, customary rules define a person's behaviour options. Norms are thus the next key predictors of behaviour-adoption considered in the RANAS model (Mosler, 2012). This is in line with TRA/TPB, in which subjective norms are the second key concept determining intention (Ajzen, 1991; Ajzen & Fishbein, 1980). SCT includes a similar construct, namely social outcomes, which is thought to influence behaviour directly and indirectly through goal formation (Bandura, 2004). Norms are also more implicitly captured in the HBM (i.e. perceived benefits and barriers; Rosenstock, 1966), PMT (i.e. response costs and extrinsic rewards of a maladaptive behaviour; Rippetoe & Rogers, 1987) and the HAPA (i.e. outcome expectations; Schwarzer, 2008). In line with later developments in TRA/TPB, the RANAS model considers two types of social norms, *injunctive* or subjective norms and *descriptive norms* (Rivis & Sheeran, 2003). The former are perceptions about which behaviours are approved or disapproved by important others (e.g. whether family members expect the mother to wash her hands) and the latter are perceptions of what others typically do (e.g. whether family members wash their hands; Cialdini, Kallgren, & Reno, 1991). Studies testing TPB revealed smaller associations with intentions and behaviour for subjective norm than for the remaining predictors (i.e. attitudes and perceived behavioural control; Conner & Sparks, 2009). Descriptive norm has been found to explain additional variance in behavioural intention (Rivis & Sheeran, 2003). Social norms emerged as handwashing predictors in developing and developed countries (e.g. Abdella et al., 2014; Alp et al., 2011; Clayton & Griffith, 2008; Curtis et al., 2009; Devine et al., 2012; McLaws et al., 2012; Whitby et al., 2006; Yardley et al., 2011; but see Jenner et al., 2006).

In addition to social norms, the RANAS model also includes *personal norm* as a behaviour antecedent (Mosler, 2012). Personal norm represents the expectations one holds for oneself (Schwartz, 1973). Personal norm concepts, namely anticipated regret and moral norm, have indeed been found to increase explained variance above TPB-constructs in intentions related to driving behaviour (Parker, Manstead, & Stradling, 1995). To my knowledge, personal norm has never been tested in relation with handwashing behaviour. It should be mentioned that there are recommendations against considering personal norm as it is rather a sub-dimension of intention than a separate predictor (Conner & Sparks, 2009).

Altogether, social norms, especially descriptive norms, can be seen as key (de-)motivators to behaviour adoption. Norms set standards with which one wants to comply. Targeting norms to motivate people to change behaviour might be useful in handwashing interventions.

Ability factors

While risk, attitude and norm factors may motivate behaviour adoption, according to Bandura (2004) self-efficacy is the key foundation of behaviour, without which the other motivators are rendered futile. Self-efficacy is defined as “the conviction that one can successfully execute the behaviour required to produce the [intended] outcomes” (Bandura, 1977, p. 193). In SCT self-efficacy is the core concept and is assumed to influence behaviour directly and indirectly by affecting all remaining behavioural predictors (Bandura, 1977, 2004). In reaction to the central role that Bandura assigned to self-efficacy, other SCMs were adapted. PMT included self-efficacy as an additional behavioural antecedent (Rippetoe & Rogers, 1987). With the introduction of perceived behavioural control (which parallels the notion of self-efficacy) as additional determinant of intention, TRA was extended to TPB (Ajzen, 1991). In studies testing these theories, self-efficacy and perceived behavioural control emerged as key predictors of behavioural intention and health behaviour (Conner & Sparks, 2009; Luszczynska & Schwarzer, 2009; Norman et al., 2009). Similar results were found with regard to handwashing in developed countries (e.g. Clayton & Griffith, 2008; Jenner et al., 2006; Whitby et al., 2006; but see also Yardley et al., 2001; O'Boyle et al., 2001) and handwashing in healthcare settings in developing countries (Alp et al., 2011; McLaws et al., 2012). Related to domestic handwashing in developing countries, to my knowledge self-efficacy has not been investigated yet. However, as handwashing is quite a simple behaviour, it can be assumed that self-efficacy concerns not so much the behaviour performance itself but rather the perceived ability to perform the behaviour at all key times (see also Affleck & Pelto, 2012; Curtis et al., 2009).

Already Bandura acknowledged that self-efficacy refers not only to the belief in one's capability to initiate and execute a behaviour but also to the belief in one's persistency in behaviour execution in face of difficulties (Bandura, 1977, 2004). This functional difference in the self-efficacy construct was addressed in more detail in the HAPA (Schwarzer, 1992, 2008). The HAPA was developed particularly in consequence of the often found 'intention-behaviour gap': while the aforementioned factors of risk perception, attitudinal beliefs, social norms and self-efficacy have been found to be quite successful in explaining behavioural intention, intention itself explains only around 28% of the variance in behaviour and around 7% in behaviour change when controlling for past behaviour (Sheeran, Milne, Webb, & Gollwitzer, 2009). This intention-behaviour gap is strikingly revealed in the finding that only around half of the people with positive intentions towards healthy behaviour manage to translate their intentions into practice (Sheeran et al., 2009). To bridge the intention-behaviour gap, the HAPA – as the only of the presently discussed SCMs – distinguishes between a motivational phase that leads to a behavioural intention and a volitional phase that leads to actual behaviour (Schwarzer, 2008; Schwarzer, Lippke, & Ziegelmann, 2008). It further suggests that pre- and post-intentional factors have to be distinguished, with the latter determining whether an intention translates into behaviour. In accordance to this, the HAPA conceptualises self-efficacy as being phase-specific. *Action or motivational self-efficacy* represents the belief in one's general behavioural capability and refers to the motivational phase. In the volitional phase, two types of *volitional self-efficacy* are thought to be critical, *maintenance* and *recovery self-efficacy*. The former refers to the belief in one's capability to deal with emerging barriers during behaviour maintenance, while the latter represents the belief in one's capability to recover from relapse. Evidence for the distinction between motivational and volitional self-efficacy is provided by several studies (e.g. Luszczynska & Schwarzer, 2003; Ochsner, Scholz, & Hornung, 2013). In the RANAS model the conceptual elaboration of self-efficacy is acknowledged and all three types of self-efficacy are considered (Mosler, 2012). To my knowledge, motivational and volitional self-efficacy have not yet been explicitly investigated with regard to handwashing behaviour.

In addition, the RANAS approach assumes that a certain level of knowhow is required for people to feel capable to act (Mosler, 2012). Therefore, a*ction knowledge* is considered an additional ability factor. It represents the expertise of performing a behaviour (Frick, Kaiser, & Wilson, 2004). With regard to handwashing, essential knowhow is when, how and for how long to wash hands and how to dry them. However, research in developing countries revealed that even when the majority of a population is aware of handwashing key times (71%-99%), only a minority (14%-36%) acts accordingly (Steadman Group, 2007; Vivas et al., 2010). That is, even if action knowledge is a crucial prerequisite of correct behaviour performance, it might not be a key determinant of practice.

To sum up, in accordance to SCT (Bandura, 1977) and HAPA (Schwarzer, 2008) it can be assumed that a feeling of self-efficacy is essential for people to start and maintain a behaviour, also in terms of handwashing. Providing people with the feeling of capability can thus be seen as an essential goal of handwashing interventions.

Self-regulation factors

According to the HAPA, during the volitional phase volitional self-efficacy as well as further factors that are involved in self-regulatory processes determine whether an intention translates into behaviour and its maintenance (Schwarzer, 1992). More specifically, planning and control factors are assumed to mediate between intention and action (Schwarzer, 1992, 2008). In the RANAS model, these factors are considered in the last factor block (Mosler, 2012). *Action planning* refers to the specification of the when, where and how of an intended action (Schwarzer, 2008). An example would be “when I have finished with defecation, I wash my hands with soap and water at the handwashing station outside the house”. Action planning is closely related to the concept of implementation intentions (e.g. Gollwitzer, 1993; see also Schwarzer, 2008). Implementation intentions are ‘if-then’-plans that connect anticipated critical situations or good opportunities to act (if-component) with goal-directed actions (then-component; Gollwitzer, 1999; Sheeran et al., 2009). They have been found to have medium to large effects on goal attainment (Gollwitzer & Sheeran, 2006). For handwashing, the if- or when-component is predefined by the key times at which handwashing is necessary to prevent from disease. Still, the explicit forming of action plans or implementation intentions might facilitate the detection of and attention to key times and automate the execution of handwashing (Sheeran et al., 2009). Even more relevant for handwashing might be *coping planning*, that is the anticipation of barriers and the generation of suitable coping responses (Sniehotta, Schwarzer, Scholz, & Schüz, 2005). Such plans were found to predict physical exercise (Sniehotta, Schwarzer, et al., 2005). Coping plans can also be formulated in if-then sentences such as “if I run out of water for handwashing, then I will go and ask my neighbour for water” (see also Sheeran et al., 2009). Further *action control* is thought to help translate good intentions into healthy behaviour (Schwarzer, 1992). Three facets of action control have been distinguished, which all might be relevant for handwashing; (1) awareness of standards for action, such as “I want to always wash my hands with soap after defecation and before preparing food”; (2) self-monitoring to evaluate whether one is on track (e.g. “I have not washed my hands after defecation this morning”); and (3) discrepancy-reducing self-regulatory efforts (e.g. "I have to take care to remind myself to wash my hands after defecation"; Sniehotta, Nagy, Scholz, & Schwarzer, 2006). Action control has been found to explain health behaviour above and beyond behavioural intention (Sniehotta et al., 2006; Sniehotta, Scholz, & Schwarzer, 2005). To my knowledge, neither planning nor action control have ever been investigated with regard to handwashing behaviour.

In addition to the mentioned planning and control factors, the RANAS model considers *commitment* and *remembering*/*forgetting* as additional self-regulation factors (Mosler, 2012). This is in line with the model of prospective memory and habit development (MPMHD), which defines commitment as “internal pressure felt by a person to perform a behaviour” (Tobias, 2009, p. 411). Strong commitment to perform a behaviour is thought to increase the chances that good opportunities to act are taken. Similarly, Bagozzi (1992) and Gollwitzer (1993) emphasise the importance of commitment in goal striving and achievement because commitment binds a person to a behaviour and defines how hard a person will try and how much effort will be exerted. Commitment has been found to explain behaviour and behaviour change with regard to water consumption (Alexandra Claudia Huber & Mosler, 2013; Inauen, Tobias, & Mosler, 2014). No results are known with regard to handwashing. Commitment can be thought of as closely related to the concept of intention; also Ajzen (1985) stated the importance of commitment within intention formation. An advantage of the commitment-concept over the intention-concept is that the former takes into account the motivational nature which is inherent in volitional processes (Bagozzi, 1992).

With regard to the second additional factor suggested in the RANAS model, according to the MPMHD a behaviour is only executed when it is preferred (e.g. positive attitudinal beliefs and norms), feasible (e.g. high self-efficacy), and *remembered* at the moment of behaviour execution (Tobias, 2009). Similarly, forgetting has been suggested as a key barrier to translate intention into action (Gollwitzer & Sheeran, 2006; Sheeran et al., 2009). It is expected to be especially common when a behaviour is not yet habitualised (Gollwitzer, 1999; Tobias, 2009). The remembering of an unhabitual behaviour that is not initiated automatically, depends heavily on the situational availability of cognitive resources (Tobias, 2009). Cognitive resources will be low, when many things are dealt with at once or when one is preoccupied with a particular task (Gollwitzer & Sheeran, 2006). As to handwashing, its performance is rarely habitual in developing countries (e.g. Curtis et al., 2009). Furthermore, it is a behaviour to be performed contingent on another key behaviour or key time (e.g. food preparation, child care etc.) with the latter behaviour being likely to absorb most of the available cognitive resources. Consequently, it is expected that handwashing at key times might frequently be missed due to forgetting. In line with this, forgetting has been stated as an impediment to regular handwashing in developing but also in developed countries (Curtis et al., 2009; Pessoa-Silva et al., 2005). This is especially bothersome as handwashing is a behaviour that cannot be postponed or compensated later; so remembering the behaviour later on is of little avail (cf. Tobias, 2009). Further, forgetting to wash hands might often stay undetected, that is when one forgot to wash hands one might not notice. For other health behaviours (e.g. water filtering), forgetting is often traceable and quickly detected. However, forgetting to wash one's hands at a certain moment may never become salient. This means that one may not realize how often one intended to wash hands but forgot. This might impair processes involved in action control, particularly monitoring.

Altogether, being motivated to change might not be enough to bring about the change but self-regulation processes might be decisive; also in terms of handwashing. Providing people with the necessary self-regulatory means can thus be seen as crucial to enable a sustained and continuous behaviour change.

3.2. Additional factors potentially affecting handwashing

While the factors compiled in the RANAS model (Mosler, 2012) constitute a good basis to develop theory-based handwashing interventions, two additional factors might be essential for regular handwashing behaviour: perceived and actual impediments and preparatory behaviour.

Perceived and actual impediments

Several of the mentioned SCMs include a further concept that reflects perceived and/or actual impediments to behaviour enactment. TPB recognises that for some behaviours an individual has only limited volitional control, which may be affected by external or situational factors, such as time, opportunity or dependence on others (Ajzen, 1985). Therefore, the theory considers the concept of actual behavioural control (Ajzen, 1985). Also SCT assumes that behaviour regulation depends not only on individual factors but also on situational and sociostructural facilitators and impediments, such as unavailability of health resources (Bandura, 1998). Similarly, the HAPA considers situational barriers and opportunities because “actions are not only a function of intentions and cognitive control but are also influenced by the perceived and the actual environment” (Schwarzer, 1992, pp. 238-239). Also the HBM includes the concept of barriers (Rosenstock, 1966); however, these refer rather to the perceived costs of a behaviour (and perceived self-efficacy) than to external or situational impediments. That is, it should be distinguished between costs and impediments. Costs are thought to be at play when for example a person thinks that handwashing uses up too much water and thus decides not to wash hands; impediments hinder behaviour when a person wishes to wash hands but runs out of water. This implies that costs are assumed to hinder motivation while impediments are first of all thought to hinder enactment. With regard to domestic handwashing in developing countries impediments have been found to strongly imping upon regular handwashing: especially a lack of readily accessible soap and water in the right places and at the right times and situational time limits seem hindering (Affleck & Pelto, 2012; Curtis et al., 2009; Devine & Koita, 2010; Luby, Halder, et al., 2009). Similarly, in healthcare settings in developing and developed countries factors such as the number and location of sinks, the availability of alcohol-based hand rub, and the intensity of work or available time were found to be facilitators or impediments to handwashing (e.g. Erasmus, 2012; Erasmus et al., 2010; Jenner, Watson, Miller, Jones, & Scott, 2002). While external and situational impediments are thought to affect all behaviours, situational impediments might be especially detrimental related to handwashing because it has to be executed in predefined situations and cannot be postponed. Therefore, perceived and actual impediments should be considered during handwashing intervention development. While one can easily measure perceived impediments by means of questionnaire items, actual impediments may be measured through proxy measures such as location of handwashing facilities, available amount of water per person per day, amount of time it takes to fetch water from the water source, amount of time it takes to fetch the soap for handwashing etc.

Closely related to the concept of impediments is the second additional construct, preparatory behaviour, as it may mitigate impediments.

Preparatory behaviour

One approach to influence an individual's behaviour is to make behaviour performance easier (cf. Tobias, 2009). Paralleling the discussion about impediments to regular handwashing above, handwashing behaviour in developing countries is facilitated when water and soap are readily accessible in the right places and at the right times (e.g. Curtis et al., 2009; Luby, Halder, et al., 2009). In contexts where domestic connections to municipal water supply lines are rare, this requires preparatory behaviours, such as the set-up of handwashing facilities at convenient places, fetching water at the water source, allocating water and soap at the handwashing facilities. These preparatory behaviours are so crucial with regard to handwashing – again – because the behaviour cannot be postponed. In this aspect, handwashing parallels the behaviour of condom use. For the latter behaviour preparatory behaviours such as buying and carrying condoms were found to be key determinants (Bryan, Fisher, & Fisher, 2002; Sheeran, Abraham, & Orbell, 1999). Preparatory behaviours were also found to be relevant with regard to physical activity (Koring et al., 2013). No results are known with regard to handwashing. Preparatory behaviours, as goal-behaviours, have to be planned (see action planning above).

3.3. A handwashing behaviour change framework

While the RANAS model (Mosler, 2012) provides an excellent compilation of factors which can potentially be targeted in handwashing interventions, a limitation of the model is that it does not specify the relations between predictors. The goal of a model, however, is not only to predict an outcome but also to explain the operating mechanisms (i.e. the causal structure) as this may provide additional suggestions for behaviour change interventions (Michie et al., 2007; Schwarzer, 2013). For example, interventions might differ in their effectiveness depending on whether they target social-cognitive factors that are rather behaviour-distal (i.e. early in the causal chain) or behaviour-proximal (i.e. late in the causal chain). Therefore, the relations between the factors potentially involved in causing habitual handwashing were reflected based on the existing SCMs and outlined in a causal framework. Therein, one model was especially informative, the HAPA (Schwarzer, 1992, 2008). Consequently, the framework's causal structure largely follows this model. The aspiration of reflecting the factors causal relation is not to present an additional SCM that might replace the existing ones. Also, an empirical test of the causal framework is beyond the scope of the present thesis. Rather, the aim is to gain a conceptual framework or tool that facilitates the development of handwashing interventions. For this purpose and in line with the RANAS approach (Mosler, 2012), the framework considers as comprehensively as possible the potential social-cognitive predictors of handwashing, violating therewith the principle of parsimony.

Habitual handwashing was selected as outcome (1) because handwashing is a regular behaviour to be performed at regular times or in regular situations so that habit formation seemed feasible (Orbell & Verplanken, 2010) and (2) due to the discussed peculiarity of handwashing that cannot be compensated later on so that forming of a habit, that is an automatic behaviour initiation in a given situation, seemed preferable. The resulting causal framework, displayed in Figure 1, is explained in the following.

Simplified, habitual handwashing is assumed to be caused by a motivation process that leads to behaviour commitment, which is translated to behaviour through two processes, planning and control/preparation. Self-efficacy beliefs are expected to influence all three processes; impediments are thought to impinge upon the latter ones. Further, several back-loops and interdependencies between social-cognitive factors are supposed to be at play.

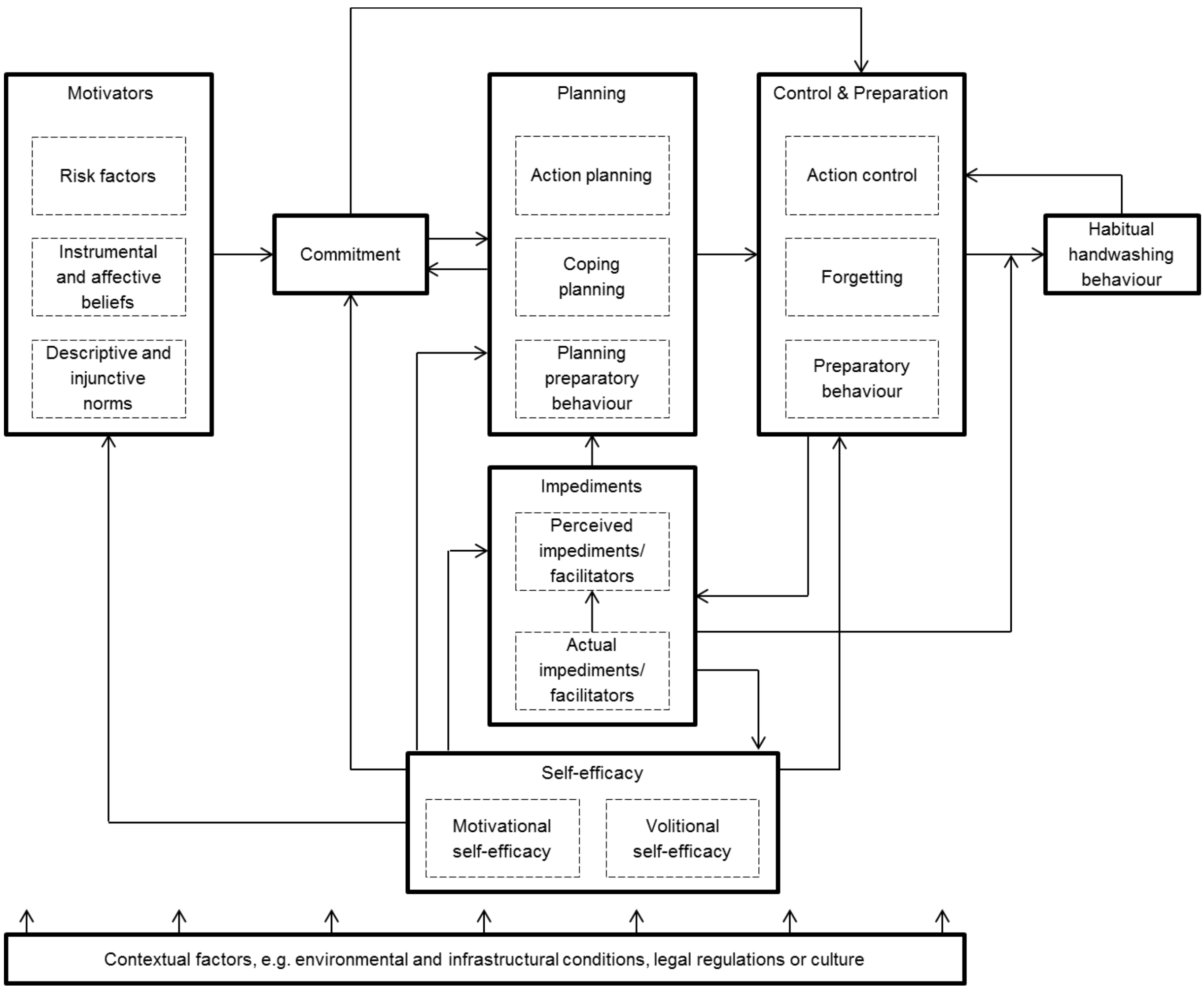

Figure 1. A causal framework to explain habitual handwashing behaviour.

Motivators are assumed to be the most behaviour-distal determinants of habitual handwashing. These include risk factors (i.e. perceived vulnerability and severity) which may bring people to contemplate about the need for handwashing (cf. Schwarzer, 2008), instrumental and affective beliefs that are more elaborated thoughts about and emotional reactions towards consequences of a behaviour or of a behaviour neglect (cf. Schwarzer, 2008), and social influences, that is descriptive and injunctive norms with regard to handwashing. Factual knowledge is implicitly included as it affects risk factors and instrumental beliefs. The factors are considered separately since different BCTs are indicated for each factor. Together risk factors, instrumental and affective beliefs, and descriptive and injunctive norms are assumed to motivate a person to adopt handwashing, that means the factors yield a commitment to change behaviour.

Commitment, however, is also contingent on *self-efficacy beliefs*. In fact, self-efficacy influences commitment directly because people only commit to behaviours that they feel capable to perform (Bandura, 2004; Schwarzer, 2008), but also indirectly as self-efficacy beliefs affect motivators. This is not only in line with SCT that states that self-efficacy beliefs shape the outcomes people expect their efforts to produce (Bandura, 2004) but also with dissonance theory (Festinger, 1962). When self-efficacy beliefs are low, to attain cognitive consonance people will adjust related cognitions, such as perceived risks, costs-benefits or affects. Three forms of self-efficacy are considered, action, maintenance and recovery self-efficacy, with the earlier being especially influential regarding motivation and the latter two regarding behaviour planning and enactment (see below; Schwarzer, 2008). Action knowledge is seen as an antecedent of self-efficacy beliefs; while people may have high self-efficacy beliefs without possessing the necessary knowledge, successful behaviour adoption will be better predicted by realistic or accurate self-efficacy beliefs, which incorporates a person’s skill and knowledge level (cf. Abraham, 2008).

Habitual handwashing is not directly caused by *commitment*. First, *planning processes* mediate the influence of commitment on behaviour (Schwarzer, 2008). Three planning forms are considered: action planning, coping planning and planning of preparatory behaviour. These are not only indirectly (through commitment) but also directly affected by self-efficacy, above all by maintenance self-efficacy (Schwarzer, 2008). *Impediments* also affect planning (Schwarzer, 1992). When people anticipate barriers they may start to plan coping mechanism or necessary preparatory behaviours to overcome them; when impediments seem overwhelming, planning may be suspended.

The effect of planning, in turn, is assumed to be mediated through *control and preparation processes* (cf. Schwarzer, 2013). First, action control is assumed to mediate planning effects because planning influences the standards for action and the cues for self-monitoring, and facilitates self-regulatory efforts (Sniehotta, Scholz, et al., 2005). Second, action planning or implementation intentions are expected to help to overcome forgetting as people are perceptually ready to encounter the specified situational cues (Conner, 2010; Gollwitzer & Sheeran, 2006; Sheeran et al., 2009). Finally, preparatory behaviours are also expected to translate planning into behaviour (Koring et al., 2013; see also Bryan et al., 2002). These control and preparation processes are not only thought to be affected by planning but also by commitment and volitional self-efficacy. First, both variables will affect how much effort is invested in preparation and control (Bagozzi, 1992; Schwarzer, 1992). Also, commitment is thought to influence forgetting; the behaviours a person is strongly committed to are less frequently forgotten than behaviours to which a person feels less committed (Tobias, 2009). Together, forgetting, action control and preparatory behaviour are thought to be the most proximal determinants of behaviour (cf. Schwarzer, 2013). With regard to handwashing habit formation, preparatory behaviours (i.e. set-up and maintenance of handwashing facilities) are assumed to deliver contextual stability; together with mitigated forgetting and action control they may facilitate frequent behaviour. Contextual stability and frequent practice are necessary prerequisites of habit formation (cf. Orbell & Verplanken, 2010). However, whether behaviour actually follows is also contingent on *actual impediments* which moderate this last step in the volitional process (cf. Schwarzer, 1992).

The framework also includes several back-loops and interdependencies between social-cognitive factors. First, perceived impediments are expected to be contingent on actual impediments but also on self-efficacy beliefs. The latter is in line with SCT that states that self-efficacy beliefs determine how obstacles are viewed, whether they are judged as being surmountable or overwhelming (Bandura, 2004). On the other hand, self-efficacy beliefs are assumed to be affected by actual impediments because the latter may hamper the experience of success; mastery experience, however, is thought to be a key source of self-efficacy (Bandura, 2004). Further, as some barriers can be overcome by appropriate coping strategies, such as preparatory behaviours, actual impediments are thought to be contingent on these. Commitment is not only assumed to influence planning but vice versa. The basic commitment that formed through motivation processes is elevated by planning (i.e. by implementation intentions; Gollwitzer & Sheeran, 2006; Tobias, 2009). Lastly, regular behaviour performance, especially formation of habitual behaviour, is expected to impinge on control and preparation, namely forgetting, as automaticity renders remembering unnecessary (Lally & Gardner, 2011; Tobias, 2009).

The presented processes are embedded in contextual factors, such as environmental or infrastructural conditions, legal regulations or culture (e.g. Dreibelbis et al., 2013; Sallis et al., 2008). These factors are not expected to directly influence behaviour but to act as most distal predictors of behaviour by shaping the considered social-cognitive factors and actual impediments (Conner & Norman, 2009a). For example, the culture and the legal system may influence social norms; environmental conditions (e.g. climate) or available infrastructure may affect actual impediments. While some of these contextual factors are not changeable (e.g. climate), others would be changeable (e.g. legal regulations) but hardly through behaviour change interventions. Instead, policy interventions would be necessary, which are not the scope of this thesis. Still, knowledge about these factors is relevant as they may affect an intervention's effectiveness and should thus be considered in intervention planning. Among others, an emergency context has to be taken into account because the most basic resources within a household may not be granted (e.g. soap or a water bucket) and thus have to be tackled within interventions.

The proposed causal framework includes nearly all factors considered in the RANAS model. Two factors, however, were excluded. First, personal norms were omitted because they are seen rather as a sub-dimension of intention than as a separate predictor (Conner & Sparks, 2009). Second, and connected to that, not intention was considered as the end-point of the motivational process but commitment because commitment has been suggested as key aspect of motivation formation (Ajzen, 1985; Bagozzi, 1992; Gollwitzer, 1993). In addition, commitment is thought to be directly modifiable through BCTs while intentions are assumed to be only changeable through targeting motivators or self-efficacy.

Further, it should be noted that the stage-idea proposed by HAPA (Schwarzer, 2008) and additional SCMs not discussed here (e.g. TTM; Prochaska, DiClemente, & Norcross, 1992) might be adopted for the present framework inasmuch as commitment may be seen as pivot point between a motivational and a volitional phase (Schwarzer, 2008) or risk factors could distinguish between precontemplation and contemplation (Prochaska et al., 1992). However, it has been criticised that the distinctions made between stages are rather fuzzy and arbitrary (Abraham, 2008). Instead, the transition from motivational to volitional processes to action can be seen as a continuum of action likelihood, which is defined by intention (or commitment) and by further social-cognitive factors, such as self-efficacy (cf. Abraham, 2008; Weinstein et al., 1998).

By summarising factors from leading SCMs, by considering additional factors that might be decisive for handwashing adoption and by specifying the assumed relations between behavioural predictors, the proposed framework constitutes a good basis to develop theory-based handwashing interventions. However, an intervention can hardly target all discussed factors at once. Thus, it is necessary to specify the determinants to be considered within an intervention. This step is discussed in the following.

4. A method to specify the key determinants to target: Population-tailoring

Several approaches have been proposed to select the behavioural determinants to target within an intervention. Which approach is followed depends partly on whether behaviour change is seen as a continuum of action likelihood or as a transition through discrete stages of change (Lippke & Ziegelmann, 2008; Weinstein et al., 1998).

4.1. Selecting social-cognitive factors according to continuum models: One-size fits all approach

Continuum theories specify factors that determine together the probability whether a person will act or not. Hereby, the factors assumed to be decisive and the way in which these combine to trigger action, is expected to be the same for every person (Weinstein et al., 1998). All but one SCMs considered in the RANAS model (Mosler, 2012) are continuum models, namely the HBM (Rosenstock, 1966), PMT (Rippetoe & Rogers, 1987), SCT (Bandura, 1977), and TRA/TPB (Ajzen, 1991; Ajzen & Fishbein, 1980). According to continuum theories, a one-size-fits-all approach can be applied to select determinants to be targeted within interventions: strengthening one or more determinants is assumed to increase the likelihood of behaviour change for all people (Abraham, 2008; Lippke & Ziegelmann, 2008). When a model specifies causality between predictors, theory-based intervention would imply to tackle the most behaviour-distal factors as these influence subsequent ones and eventually cause behaviour change (Sutton, 2008). At the same time, behaviour-distal factors explain only a small amount of variance in behaviour change when compared with behaviour-proximal factors. Thus, effectiveness of such theory-based interventions might be minimal

(Sutton, 2008). Therefore, it has been suggested to abandon a strictly theory-based approach by also targeting behaviour-proximal factors with interventions (Sutton, 2008).

4.2. Selecting social-cognitive factors according to stage theories: Stage-tailored interventions

Stage theories, such as the HAPA (Schwarzer, 2008), suggest that behaviour change evolves in discrete stages and that on each stage different social-cognitive factors are decisive (Lippke & Ziegelmann, 2008). Hence, per stage different factors determine whether a person moves to the next stage or to action. Accordingly, for each stage different determinants have to be targeted within interventions. In other words, interventions have to be tailored to the stage-specific needs of each participant (Abraham, 2008; Lippke & Ziegelmann, 2008). If stage-inappropriate determinants are targeted, interventions are expected to be ineffective or even counter-productive (Abraham, 2008). However, effective application of stage-tailored interventions requires two prerequisites to be satisfied: (1) identification of the determinants per stage and (2) unambiguous categorization of individuals to specific stages; both requirements are currently not sufficiently satisfied (Abraham, 2008; Weinstein et al., 1998). At the same time, it has been suggested that the notion that different interventions may be indicated for different persons also hold under the assumptions of a continuum model (Abraham, 2008; Weinstein et al., 1998). For example, a continuum model would predict that a planning intervention is less effective for individuals with low commitment than for individuals with high commitment, while a motivational intervention would be assumed to be effective for the former individuals but not for the latter ones. In line with this, intervention-tailoring has not been restricted to stage-tailoring but has also been applied to tailor interventions, for example to (sub-)populations (Weinstein et al., 1998).

As mentioned, building on only one SCM (no matter whether it is a continuum or a stage theory) includes the risk that crucial change processes are missed because each model covers only a set of potential behaviour determinants (Abraham, 2012). Further, behavioural determinants may be more influential with regard to a certain behaviour or within a certain population or context (Bartholomew et al., 2006; Mosler, 2012). Risk factors, for example, which have generally been found to be rather uninfluential with regard to hygiene behaviours, seem to be important behaviour determinants in refugee camps (Vujcic et al., 2014). Such context specific differences in determinants are not considered in either of the two presented approaches to select social-cognitive factors to intervene on. Altogether, to develop effective handwashing interventions in developing countries an alternative approach seemed necessary which takes multiple theories into account and targets a specific behaviour within a specific population or context.

4.3. Selecting social-cognitive factors based on a multi-theoretical approach: Behaviour- and population-tailored interventions

When applying a multi-theoretical approach for intervention development, it has been suggested to select those behavioural determinants to intervene on which seem most influential with regard to a specific problem, that is for a specific behaviour within a specific population (Abraham, 2012; Bartholomew et al., 2006; Mosler, 2012). To identify problem-relevant determinants, in a first step, theories of behaviour change and the existing evidence-base in terms of the problem at hand (e.g. handwashing in developing countries) should be consulted to obtain information on potentially relevant determinants (Bartholomew et al., 2006). With regard to handwashing, this step has been accomplished in the previous chapter. Next, the most promising determinants to be tackled in interventions in a given population have to be specified, namely the factors with the highest influence on the behaviour of interest that have additionally a high potential to change (Bartholomew et al., 2006; Mosler, 2012). This can be accomplished by means of a quantitative survey measuring the potentially relevant determinants and behaviour in the target population (Bartholomew et al., 2006; Mosler, 2012). Statistical analysis can then be used to assess the determinants' influence. One approach is to compare individuals who practice the behaviour with individuals who do not practice the behaviour; determinants that differ between the two groups are likely to be influential (between-group mean comparisons; Bartholomew et al., 2006; Mosler, 2012). Alternatively, the strength of associations between determinants and behaviour can be estimated; determinants that are strongly associated with the behaviour are likely to be important (correlation or regression analysis; Mosler, 2012). Further, the changeability of the identified determinants should be taken into account (Abraham, 2012; Bartholomew et al., 2006; Mosler, 2012). For example, when individuals already possess the necessary knowledge to perform a behaviour, knowledge cannot be modified (i.e. increased) to initiate a behaviour change (Abraham, 2012; Bartholomew et al., 2006). Changeability can be estimated by analysing the determinants' distributions in the target population (e.g. by assessing mean values; mean values that deviate from the ideal value, which is expected to facilitate behaviour change, have high changeability; Mosler, 2012). Based on the gained information in terms of influential determinants and changeability, the determinants to be targeted within interventions can be selected (Bartholomew et al., 2006; Mosler, 2012). When the determinants to intervene on are specified, BCTs have to be chosen that are expected to modify the according determinants.

5. A list of specific BCTs to target specific determinants

One could expect that SCMs include information regarding the techniques to change their respective determinants as one of their aims is to facilitate development of health behaviour interventions (Conner & Norman, 2009a). However, only few SCMs provide such information, for example SCT (Bandura, 1977). Accordingly, in recent years several scholars made the attempt to link BCTs to behavioural determinants or theories (e.g. Abraham & Michie, 2008; Bartholomew et al., 2006; Michie et al., 2013; Mosler, 2012). Only such a classification system allows a theory-based selection of an intervention's content (Michie, Johnston, Francis, Hardeman, & Eccles, 2008; Michie & Prestwich, 2010). The BCT-taxonomy by Abraham (2012), which was applied in chapter 2 to describe handwashing interventions in DEA, provides such a mapping of the considered BCTs to change processes. Abraham's classification system is the result of an iterative process, which started with a taxonomy that includes 26 reliably identified BCTs that were derived from three previous BCT lists and linked to six broad change processes (Abraham & Michie, 2008). A later taxonomy was developed based on two systematic reviews and includes 35 BCTs that experts reliably linked to 11 behavioural determinants (Michie et al., 2008). Abraham (2012) further developed the existing taxonomies to include 40 BCTs linked to 11 broad change processes. The most recent taxonomy developed by this research group, which is also the most comprehensive and elaborated classification system to date, includes 93 BCTs clustered to 16 change processes (Michie et al., 2013).

In the following, example BCTs for the potential behavioural determinants of handwashing behaviour are presented. As the aim was not to provide an exhaustive list of BCTs potentially applicable in handwashing interventions but only to give an overview on possible BCTs, the taxonomy proposed by Abraham (2012) seemed to satisfy the needs and served as a basis. While Abraham's taxonomy assigns BCTs to eleven brought change processes, here each behavioural determinant is separately considered, i.e. to each behavioural determinant one or several BCTs are allocated. The list is complemented with BCTs from the taxonomy provided in the RANAS approach, which was explicitly developed for the water, sanitation and hygiene sector in developing countries and thus seemed suitable for the present purpose (Mosler, 2012). Further, it can be assumed that an intervention's effectiveness is influenced (1) by the mode of delivery, that is whether an intervention is delivered by means of mass media (including audio-visual and written media), in a group setting or by one-to-one communication, and (2) by an intervention's degree of activation of the beneficiaries, that is whether an intervention is active or passive (Mosler & Tobias, 2007). Therefore, for each BCT the possible modes of delivery and degree of activation are stated. According to the heuristic systematic model of information processing, high involvement leads to systematic information processing and thus to more stable attitude change (Chaiken, 1980). Therefore, it is assumed that an intervention (whether it delivers information or not) is more effective in changing behaviour sustainably, the more it induces involvement of the beneficiaries. In general, one-to-one communication and group settings are expected to induce more involvement and thus to be more effective than mass media.[3] Similarly, active interventions are expected to induce more involvement and thus to be more effective than passive interventions.

Table 3 presents for each social-cognitive factor of the causal framework presented in chapter 3.3 one or several BCTs, which are expected to change the according determinant along with the applicable modes of delivery and the BCT's degree of activation. Therewith, the basis for a theory-based selection of BCTs to promote handwashing is provided. To also allow an evidence-based selection, the BCTs' effectiveness has to be verified (cf. Davidson et al., 2003; Michie & Abraham, 2004). The handwashing intervention studies summarized in Table 2, chapter 2.2 of this Part applied only 12 of the 29 BCTs presented here and for several the evidence is mixed (i.e. provide information, BCT-1). Accordingly, further research is needed to test the BCTs effectiveness in terms of handwashing promotion. To establish causality, an experimental design is required: BCTs should be applied experimentally by using intervention and control groups. Further, not only the BCTs' effectiveness should be assessed, but it should also be investigated whether the BCTs actually changed the determinants that they were expected to influence (and therewith, caused behaviour change), i.e. the underlying change processes should be tested (cf. Lippke & Ziegelmann, 2008; Michie & Abraham, 2004; Michie et al., 2007). Such research is essential because so far there is only preliminary evidence with regard to BCTs to target specific determinants (Lippke & Ziegelmann, 2008). That is, while several taxonomies have been developed, which map specific BCTs to specific determinants, most of the assumed links have not been empirically

[3] Electronic communication is not considered as a mode of delivery as internet coverage is not yet reliably provided in developing countries.

Table 3. Overview on BCTs to target social-cognitive factors potentially involved in the adoption of habitual handwashing behaviour

SC factors	BCTs	Delivery mode	Activation	Additional information
BCTs to target motivators				
Vulnerability	BCT-3: emphasize personal susceptibility	2 or 3	Passive	Requires personalised information and thus interpersonal communication.
	BCT-4: prompt beneficiaries to assess their own risk	1–3	Active	–
	(BCT-1 and BCT-2 may induce contemplation about vulnerability and thus may also be employed)	See instr. beliefs	See instr. beliefs	See instr. beliefs
Severity	BCT-5: arouse fear by emphasizing severity of negative consequences	1–3	Passive	Although a passive technic, due to the arousal of fear, high involvement is expected.
	(BCT-1 and BCT-2 may induce contemplation about vulnerability and thus may also be employed)	See instr. beliefs	See instr. beliefs	See instr. beliefs
Instr. beliefs	BCT-1: provide general information on behaviour-health links BCT-2: describe likely material consequences of behaviour	1–3	Passive	Active option: group tasks in which participants generate the information (about consequences) themselves (e.g. three-pile-sorting).
Affective beliefs	BCT-6: describe likely emotional or affective consequences of behaviour (neglect)	1–3	Passive	–
	BCT-7: prompting self-assessment of affective consequences	1–3	Active	–
Descr. norms	BCT-9: provide information about others' behaviour	1–3	Passive	Active option: prompt beneficiaries to reflect others' behaviour.
	BCT-11: encourage beneficiaries to seek social comparison opportunities	1–3	Active	–
	Public commitment	1–3	Active	–
Inj. norms	BCT-10: provide information about others' approval of the beneficiary's behaviour	1–3	Passive	Active option: prompt beneficiaries to reflect whether others approve a behaviour or not.
	Public commitment	1–3	Active	–

(continued)

Table 3 (continued). Overview on BCTs to target social-cognitive factors potentially involved in the adoption of habitual handwashing behaviour

SC factors	BCTs	Delivery mode	Activation	Additional information
BCTs to target commitment				
Commitment	BCT-31: agree a written behavioural contract	1–3	Active	–
	BCT-29: prompt goal setting	1–3	Active	–
	BCT-30: prompt specific planning/goal setting	1–3	Active	Includes forming of implementation intentions.
	BCT-37: create environmental prompts/cues (cf. Tobias, 2009)	1–3	Active or passive	Passive, when prompts are set up; active, when beneficiaries set up their own prompts.
	Public commitment	1–3	Active	–
BCTs to target planning				
Action planning	BCT-30: prompt specific planning	1–3	Active	Includes forming of implementation intentions.
Coping planing	BCT-21: prompt barrier identification and planning in relation to anticipated barriers	1–3	Active	–
Prep. behav. plan.	BCT-30: prompt specific planning	1–3	Active	Includes forming of implementation intentions.
	BCT-21: prompt barrier identification and planning in relation to anticipated barriers	1–3	Active	–
BCTs to target control and preparation				
Action control	BCT-22: prompt self-monitoring	1–3	Active	–
	BCT-23: provide feedback on performance	2 or 3	Active	Requires personalised feedback and thus interpersonal contact.
	BCT-30: prompt specific planning	1–3	Active	Includes forming of implementation intentions.
	BCT-39: provide contingent reward (to boost self-monitoring and self-regulatory efforts)	2 or 3	Passive	Requires personalised reward and thus interpersonal contact.
	BCT-40, prompt self-reward (to boost self-monitoring and self-regulatory efforts)	1–3	Active	–

(continued)

Table 3 (continued). Overview on BCTs to target social-cognitive factors potentially involved in the adoption of habitual handwashing behaviour

SC factors	BCTs	Delivery mode	Activation	Additional information
Forgetting	BCT-37: teach to use environmental cues or create prompts/cues	1–3	Active or passive	Passive, when prompts are set up; active, when beneficiaries set up their own prompts.
	BCT-36: prompt organisation of social support	1–3	Active	E.g. people may remind each other to perform.
	BCT-30: prompt specific planning	1–3	Active	Includes forming of implementation intentions.
	BCT-21: prompt barrier identification and planning in relation to anticipated barriers	1–3	Active	–
Prep. behav.	BCT-30: prompt specific planning	1–3	Active	Includes forming of implementation intentions.
	BCT-21: prompt barrier identification and planning in relation to anticipated barriers	1–3	Active	–
BCTs to target self-efficacy				
Motivational SE[a]	BCT-16: provide instructions	1–3	Passive	–
	BCT-20: prompt practice	1–3	Active	–
	Provide or promote facilitating resources	2 or 3 (and 1, in case of infrastructure promotion)	Active or passive	BCT may remove impediments and/or ease behaviour performance and thus allow mastery experience. Active, when infrastructure is not installed but only the necessary resources are provided for self-installation, and even more, when facilitating infrastructure is only promoted.
	BCT-36: prompt organisation of social support	1–3	Active	BCT may remove impediments and/or ease behaviour performance and thus allow mastery experience.
	BCT-18: modelling or demonstration	1–3	Passive	–
	BCT-14: use argument to bolster self-efficacy	1–3	Passive	–

(continued)

Table 3 (continued). Overview on BCTs to target social-cognitive factors potentially involved in the adoption of habitual handwashing behaviour

SC factors	BCTs	Delivery mode	Activation	Additional information
Volitional SE	BCT-15: prompt reattribution of past successes and failures	1–3	Active	–
	BCT-36: prompt organisation of social support	1–3	Active	BCT may remove impediments and/or ease behaviour performance and thus allow mastery experience.
	BCT-14: use argument to bolster self-efficacy	1–3	Passive	–
	BCT-21: prompt barrier identification and planning in relation to anticipated barriers	1–3	Active	–
BCTs to target impediments				
Impediments	BCT-21: prompt barrier identification and planning in relation to anticipated barriers	1–3	Active	–
	BCT-36: prompt organisation of social support	1–3	Active	
	Provide or promote facilitating resources	2 or 3 (and 1, in case of infrastructure promotion)	Active or passive	Active, when infrastructure is not installed but only the necessary resources are provided for self-installation, and even more, when facilitating infrastructure is only promoted.

Note. SC factors = Social-cognitive factors. Instr. Beliefs = Instrumental beliefs. Descr. norms = Descriptive norms. Inj. norms = Injunctive norms. Prep. behav. plan. = Preparatory behavior planning. Prep. behav. = Preparatory behavior. Motivational SE = Motivational self-efficacy. Volitional SE = Volitional self-efficacy. BCTs according to Abraham (2012) and (Mosler, 2012). [a] Some BCTs suggested to enhance self-efficacy seem less relevant with regard to handwashing (e.g. BCT-17, set graded tasks/goals or BCT-19, prompt mental rehearsal or technics regarding emotional arousal; Bandura, 1977) as handwashing per se is not a difficult task but rather the regular performance of handwashing may be difficult. Accordingly, these were omitted from the present list.

verified yet. However, as long as we do not know whether a BCT actually changes a specific determinant, theory-based practice is not fully accomplishable (Michie & Abraham, 2004). Underlying change processes can be investigated by means of mediation analysis of data containing not only intervention outcomes (i.e. behaviour, see below) but also the intermediatory behavioural determinants.

6. Intervention evaluations: How to measure handwashing behaviour

Intervention evaluations are needed (1) to establish the necessary evidence-base related to interventions' effectiveness for evidence-based practice and (2) to establish the necessary evidence-base with regard to underlying change processes for theory-based practice. For evaluations, the application of an appropriate outcome measure is essential as the evidence of effectiveness can be contingent on the considered type of outcome (Michie & Johnston, 2012). Aid agencies rarely evaluate their interventions with regard to an outcome. More often, only program outputs are considered (e.g. number of people targeted, number of soaps distributed). This is partly due to the fact that donors usually require only reporting of outputs and often prefer to donate money for programs rather than their evaluation (cf. Vujcic et al., 2014). However, only outcome evaluations enable rigorous tests of effectiveness. The handwashing intervention studies summarized in Table 2, chapter 2.2 in this Part applied several outcome measures including disease prevalence, handwashing self-reports, observed handwashing, handwashing proxy measures and handwashing determinants such as knowledge (results on the latter outcome were not presented in Table 2). Because the endpoint of a *behavioural* intervention is *behaviour*, it has been advocated that only behaviour is the appropriate outcome measure for intervention evaluations (Michie & Johnston, 2012). To look at effectiveness related to outcomes further down the causal chain (e.g. disease prevalence) is not recommended because intervening variables (e.g. water quality) may distort the link between the critical behaviour (e.g. handwashing) and the latter outcome (Michie & Johnston, 2012).[4] Similarly, looking at effectiveness related to outcomes early in the causal chain (e.g. knowledge or attitudes) is also problematic because these do not translate directly into behaviour (Michie & Johnston, 2012). Thus, potentially suitable outcome measures for handwashing intervention evaluations are observed and self-reported handwashing and

[4] It should be mentioned that research on handwashing interventions' effects on disease outcomes such as diarrhoea prevalence were essential to establish the rational for promoting handwashing behaviour.

(maybe) handwashing proxy measures. The three measures have advantages but also major shortcomings with regard to their validity, efficiency and the collectable data. These pros and cons are discussed in the following sections.

6.1. Structured observation of handwashing behaviour

In structured observations, handwashing behaviour of target persons is observed and recorded during several hours, ideally starting in the early morning when many of the handwashing key times occur (Biran et al., 2008; Ram, 2013). Assumed advantages of structured observations are first, that they are said to be objective and thus a valid measure of ‘actual’ handwashing behaviour, and second, that they allow the collection of individual data (e.g. data on a specific person instead of household data) and detailed information (e.g. key times, cleansing agents; Ram, 2013). Shortcomings of structured observations are first, that they are biased by reactivity towards socially desirable practices (e.g. Gittelsohn, Shankar, West, Ram, & Gnywali, 1997) and second, that their reliability (i.e. their retest-reliability within several observation sessions) is rather low (Cousens, Kanki, Toure, Diallo, & Curtis, 1996). These shortcomings question the first claimed advantage, the validity of (single-session-)observations to assess ‘actual’ handwashing behaviour. Even more challenging, observations are very time-consuming and thus cost-inefficient; usually, a data collector can conduct only one observation a day compared to seven or more structured interviews (used for self-reports) administrable a day (Biran et al., 2008).

6.2. Self-reported handwashing behaviour

Handwashing behaviour can also be measured through interview questions. Advantages of self-reported handwashing measures are first, that they are very easily and efficiently collected and second, that they also allow the collection of individual data and detailed information (Ram, 2013). The major shortcoming of self-reported handwashing measures is that they tend to be inflated when compared to observed data, that is they are biased towards socially desirable practices (e.g. Halder et al., 2010; see also Ram, 2013; Manun'Ebo et al., 1997). This compromises their validity to measure ‘actual’ behaviour.

6.3. Handwashing proxy measures

As alternative measures for handwashing behaviour several proxy measures have been suggested, such as the rapid observation of handwashing materials (e.g. observed presence of soap and water) and soap consumption (Ram, 2013). Advantages of these measures are that they are objective and very efficiently collected (Ram, 2013). A major shortcoming of these proxy measures is that they do not provide individual data but only household data. To evaluate the effectiveness of interventions, however, behaviour change in an individual, targeted person is often of interest. Further, it can be questioned whether these proxy measures are a valid measure of 'actual' handwashing behaviour and whether their application still complies to the standard to measure *behaviour* in handwashing intervention evaluations (cf. Michie & Johnston, 2012).

Altogether, to date no handwashing behaviour measure has been found that is at the same time efficient, valid and delivers the needed data (i.e. individual data on handwashing *behaviour*).[5] Still, structured observation, despite its shortcomings, has generally been recommended to evaluate handwashing interventions, and serves as standard of comparison, while the application of self-reports to measure handwashing practice has usually been advised against (e.g. Biran et al., 2008; Ram, 2013). However, due to the high cost burden the collection of observational data is rather unrealistic for large-scale or minimally funded projects, so that their evaluation is challenged. Therefore, further research is needed to find measures of handwashing behaviour that are valid, at the same time efficient and deliver the needed data. Among other things, an investigation of the bias in self-reported handwashing behaviour might provide indications for new measures.

7. Objectives and research questions

The broad aims of this thesis are (1) to evaluate handwashing interventions in emergency relief and recovery aid; (2) to investigate the potential of theory- and evidence-based population-tailored interventions compared to standard approaches in DEA; and (3) to explore a major challenge for handwashing intervention evaluations, that is over-reporting in self-reported handwashing behaviour. In the following, more specific research aims and questions that were derived from these broad aims are presented.

[5] Several additional handwashing behaviour measures have been proposed and tested, including the measurement of microbiological hand contamination, pocket voting, observation of behaviour during handwashing demonstration, visual inspection of hand cleanliness, and movement sensors embedded in soaps (Biran et al., 2008; Ram, 2013). However, also these measures do not satisfy all three criteria, namely validity, efficiency and provision of individual data.

7.1. Specify the social-cognitive determinants of handwashing behaviour in developing countries

Knowledge about the social-cognitive determinants of a health behaviour are essential to develop effective behavioural interventions but also to evaluate them (Conner & Norman, 2009a; Lippke & Ziegelmann, 2008). The existing evidence-base on determinants of handwashing behaviour stems primarily from developed countries and mainly from healthcare settings (e.g. Alp et al., 2011; Whitby et al., 2006). Only one quantitative study looking at determinants of *domestic* handwashing in a *developing* country is known (Aunger et al., 2010). No evidence is available on handwashing determinants in an emergency context. However, key behavioural determinants may differ between populations (e.g. developed versus developing countries) or between contexts (e.g. development versus emergency context; Bartholomew et al., 2006; Mosler, 2012). Further, in developed and developing countries, mainly factors involved in motivational processes (including self-efficacy) have been studied so far but rarely those involved in volitional processes (with impediments and forgetting being exceptions). Altogether, the evidence-base on social-cognitive factors explaining domestic handwashing behaviour in developed countries is limited, especially with regard to an emergency context. Therefore, Part Two of this thesis aims to specify the social-cognitive determinants of domestic handwashing in emergency (i.e. recovery) contexts in developing countries. This is accomplished by means of two studies, one in Haiti (study 1) and a second in Ethiopia (study 2). The research questions are:

(1) Which social-cognitive factors are related to domestic handwashing in Haiti and Ethiopia?

(2) What are the similarities and differences in social-cognitive determinants of handwashing in these two countries?

By testing the behavioural determinants in two different populations, important information can be gained on the generalizability of social-cognitive determinants of handwashing. If behavioural determinants were found to be very similar, this information might be used for selecting the determinants to target in future interventions in other developing countries, especially during an emergency (recovery). On the other hand, if behavioural determinants were found to be different, the need for population-tailored interventions that take into account the specific setting and audience would be emphasized.

While Part Two explicitly focuses on the social-cognitive determinants of handwashing, determinants were also investigated in Parts Three and Four. For the respective research questions see the following subchapters.

7.2. Evaluate standard handwashing interventions in emergency relief and recovery aid

To date, handwashing interventions have not yet been quantitatively evaluated in an emergency relief or recovery setting. While handwashing interventions in emergency relief and recovery might work in analogy to a development context, it is credible that an emergency situation influences the interventions' effectiveness (Parkinson, 2009; Vujcic et al., 2014). Therefore, Part Three aims at evaluating standard handwashing intervention activities in emergency relief and recovery situations by means of a correlative study in Haiti (study 3). While it is necessary to assess the 'effectiveness' of interventions, it is also informative to investigate the underlying change processes of applied interventions (Michie & Abraham, 2004). Therefore, the corresponding research questions are:

(3) Which intervention activities are related to handwashing behaviour through which social-cognitive factors?

(4) How strongly are the different intervention activities related to handwashing behaviour?

While a correlative study only provides approximate insights into the effectiveness of handwashing interventions during emergencies, it is an important step towards evidence-based practice in emergencies.

7.3. Develop and evaluate theory- and evidence-based population-tailored interventions

Theory- and evidence-based interventions are thought to change behaviour more effectively than those lacking a theoretical underpinning (Michie & Abraham, 2004; Michie et al., 2007). Handwashing interventions in humanitarian aid are rarely theory- or evidence-based (Aboud & Singla, 2012). Therefore, Part Four aims to develop and test theory- and evidence-based interventions that are additionally tailored to the respective population. This is accomplished by means of a longitudinal study in Ethiopia. In Chapter I of Part Four, first the intervention potential of the social-cognitive factors is assessed with regard to the specific population (study 4, step 1 and 2). The research question is:

(5) Which social-cognitive factors have the greatest intervention potential to promote handwashing?

This assessment provides the basis to develop theory- and evidence-based interventions, which are tailored to the target population; that is BCTs are selected that are assumed to modify the factors with the highest intervention potential in the specific population (study 4, step 2). These interventions are tested in combination with a standard intervention in comparison to a group receiving only the standard intervention (study 4, step 3). The corresponding research question is:

(6) Are theory- and evidence-based population-tailored interventions more effective in changing handwashing than a standard intervention?

Theory-based interventions assume that they change behaviour by changing specific behavioural determinants. Evidence about techniques changing specific determinants is still limited (Lippke & Ziegelmann, 2008). To my knowledge, the change processes of handwashing interventions have not been investigated yet. Therefore, Chapter 2 of Part Four aims to test the underlying change processes of the developed theory- and evidence-based population-tailored interventions by means of longitudinal data from Ethiopia (study 5). The research question is:

(7) Do the theory-based interventions change handwashing behaviour by affecting specific social-cognitive factors?

These results will contribute to a much needed evidence-base on techniques changing specific determinants, which is necessary to allow truly theory-based practice.

7.4. Investigate factors explaining the bias between observed and self-reported behaviour

Intervention evaluation is only possible when an appropriate outcome measure is available (Michie & Johnston, 2012). Self-reported handwashing measures have been criticised to be biased by socially desirable responding (Ram, 2013). The standard of comparison, structured observations, however, is too costly to allow regular evaluations. So far, no alternative measure has been found (Biran et al., 2008). It is credible that a better understanding of the factors biasing self-reported handwashing (above and beyond socially desirable responding) would indicate measures to mitigate the bias. Therefore Part Five aims to investigate social desirable responding and additional factors potentially explaining the bias between self-reported and observed handwashing based on a study in Ethiopia (study 6). The corresponding research questions are:

(8) Are socially desirable responding and additional factors associated with over-reported handwashing?

(9) Explain additional factors over-reporting beyond socially desirable responding?

Further, alternative self-report measures, which are assumed to reduce the influence of social desirable responding and additional factors, are investigated. The research question is:

(10) Do alternative self-report measures decrease the bias in self-reported handwashing?

The results may contribute to resolve a current challenge for handwashing intervention evaluations: the lack of an efficient and valid measure of handwashing behaviour.

The following and last chapter of Part One describes the surveys based on which these research questions were answered.

8. Description of the surveys

Three surveys were conducted. Survey 1 was situated in Haiti and surveys 2 and 3 in Ethiopia. While all surveys were cross-sectional, surveys 2 and 3 applied the same sample and thus together provided longitudinal data. The data collected with these three surveys delivered the basis for the six empirical studies constituting this thesis (see Table 4 for an overview).

8.1. Survey sites and time

For survey 1 field research was conducted in Haiti in April and May 2011 during the recovery phase of an emergency caused by an earthquake in January 2010 and a cholera outbreak in October 2010. Data were collected in 20 displacement camps and poor neighbourhoods in the metropolitan area of Port-au-Prince (urban and peri-urban) and in rural areas in the West Department of Haiti (see Figure 2, left side). Three affiliates of an INGO had implemented hygiene promotions and cholera response in these locations for over a year, starting after the disastrous earthquake and scaling up after the cholera outbreak. The 20 sites were selected randomly from all the locations in which the three affiliates had worked, while ensuring that the site type (camp versus neighbourhood), region type (urban, peri-urban and rural) and affiliates were as equally as possible represented.

For survey 2 and 3, data were collected in four rural kebeles in the Borena zone of southern Ethiopia (see Figure 2, right side, and Part Four for details on study sites selection procedures). The Borena zone is a semi-arid region inhabited by semi-nomadic pastoralists. It is recurrently hit by droughts threatening the survival of livestock and causing food insecurity and famine. Since the 1970s, governmental organisations and NGOs have been working in the Borena Zone to mitigate the droughts. Parts of the emergency aid have been hygiene interventions. In 2006 the first handwashing intervention was implemented in the region. The conditions for promoting regular handwashing are extremely difficult due to the aridity and because water supply coverage is low. The last major drought occurred in 2011-2012 and affected the entire Horn of Africa. In the four study kebeles, a local NGO together with an INGO conducted hygiene promotions as part of their drought response. Survey 2 was conducted in February 2012 during the recovery phase of this emergency, survey 3 one year later in February and March 2013.

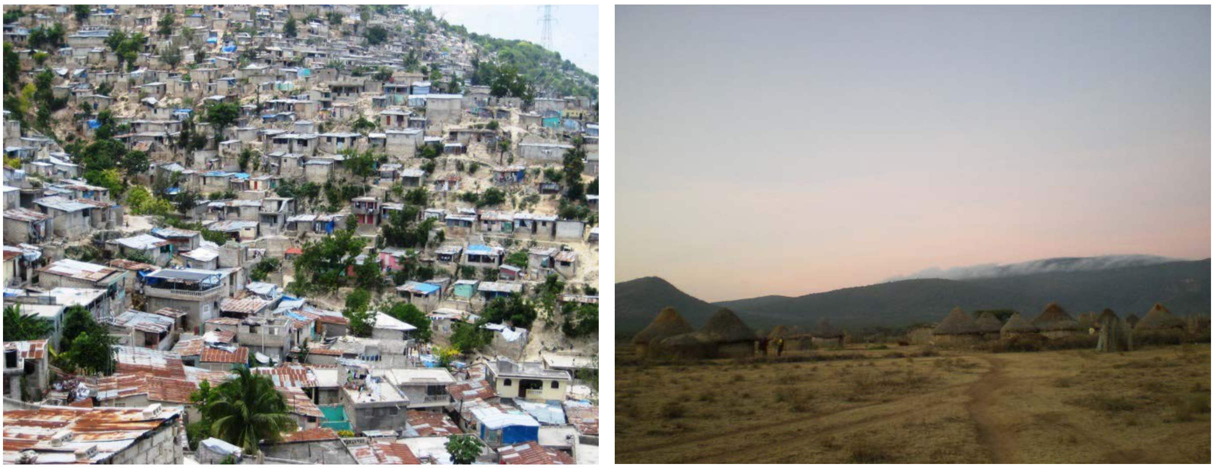

Figure 2. The sites of the three surveys: Metropolitan area of Port-au-Prince and kebeles in the Borena zone, Ethiopia.
Left: A neighbourhood in Port-au-Prince, Haiti (Picture by Johanna Braun). Right: A village in the Borena zone, Ethiopia.

It should be noted that the emergency situations in Haiti and Ethiopia were of rather different nature. An earthquake is a rapid onset disaster causing immediate destruction to lives and livelihoods and requiring immediate help (Wisner, Blaikie, Cannon, & Davis, 2003). A drought, on the other hand, is a slow onset disaster; the threat to lives and livelihoods unfolds over a longer period, with the risk that the need for help is not recognised (Wisner et al., 2003).

8.2. Survey designs

Survey 1 was a cross-sectional survey. Data covered handwashing behaviour and their social-cognitive determinants. Further, respondents were interviewed with regard to their participation in the handwashing activities that three affiliates of an INGO had conducted after the earthquake and in response to the cholera outbreak. The data gained in survey 1 were used in study 1, presented in Part Two, and study 3, presented in Part Three (see Table 4).

Table 4. Overview on the conducted studies and the applied surveys

Part of the thesis	Study	Survey 1	Survey 2	Survey 3
Part Two	Study 1: Social-cognitive factors in Haiti	x		
	Study 2: Social-cognitive factors in Ethiopia		x	
Part Three	Study 3: Evaluation of standard interventions	x		
Part Four	Study 4: Effectiveness of theory-based interventions		x	x
	Study 5: Underlying mechanism of interventions		x	x
Part Five	Study 6: Over-reporting in handwashing self-reports			x

Survey 2 was also cross-sectional. The survey assessed handwashing behaviour and their social-cognitive determinants. As displayed in Table 4, the data were applied in study 2, which is presented in Part Two, and served as baseline data for the longitudinal studies 4 and 5, which are presented in Part Four (see below for more detail). In addition, respondents were interviewed with regard to their participation in the handwashing activities that a local non-governmental organisation (NGO) had conducted as part of the drought response in cooperation with an INGO. The information was applied in an intervention evaluation that is presented elsewhere.

Survey 3 was conducted with the same sample as survey 2.[6] It was also a cross-sectional survey. The same measures on handwashing behaviour and social-cognitive determinants were applied as in survey 2. In addition, respondents were interviewed with regard to their participation in the theory- and evidence-based population-tailored interventions, which were implemented between survey 2 and 3 (see below). Further, additional measures were applied to investigate factors explaining the bias between self-reported and observed behaviour. The data gained in survey 3 served as follow-up data for the longitudinal studies 4 and 5, presented in Part Four (see below and Table 4). They were also used in study 6, which is presented in Part Five (see Table 4).

[6] In one kebele (smallest administrative unit in Ethiopia) additional households were gained in survey 3 as the sample size was very small (see Chapter I in Part Four for more details).

Longitudinal studies 4 and 5. Surveys 2 and 3 together provided longitudinal data, which was used to investigate theory- and evidence-based population-tailored interventions in studies 4 and 5, which are presented in Part Four. Data gathered in survey 2, which was conducted in the beginning of 2012, served as baseline data. According to this data, two handwashing interventions were developed. From October 2012 to January 2013 the local NGO implemented the interventions in a full factorial design. Four Ethiopian kebeles (smallest administrative unit in Ethiopia) served as intervention and control groups. To test the theory- and evidence-based population tailored interventions rigorously, an education intervention served as baseline intervention and was conducted in all four kebeles, including the control kebele (cf. Williams, 2010). Survey 3 was conducted around three months after termination of the interventions in February and March 2013, i.e. the data served as follow-up.

8.3. Participant selection

In survey 1 and 2, households were selected using a modified random route sampling (Hoffmeyer-Zlotnik, 2003). For that, each camp, neighbourhood or village under study was subdivided into ten and fourteen, respectively, areas to which the data collectors were randomly assigned. In each area, one house or tent was randomly selected as a starting point and the assigned data collector was instructed to try and interview (and observe) every third household when walking in a specified direction. Only primary caregivers were surveyed, since they are responsible for childcare and preparing food and thus have the highest chance of spreading diarrheal disease to the family. Also, they may act as models and therefore, influence the family’s hygiene behaviour. In Ethiopia, in addition, only households with at least one child younger than five years were targeted as children under the age of five years are most vulnerable to diarrhoea. In survey 3, the participants from survey 2 were re-approached. In all three surveys refusal rate was very low.

8.4. Data collection procedures

In survey 1 data were collected by 45-minutes-long structured face-to-face interviews in Haitian Créole. The interviews were carried out by a gender-balanced team of 10 local students and scientists.

In survey 2 and 3, data were collected by one-hour-long structured face-to-face interviews in Afan Oromo. In addition, household observations were conducted, that is data collectors observed primary caregivers’ handwashing behaviour at key times (Ram, 2013).

The observations lasted for three hours per household and preceded the interviews. In survey 2, only part of the study households were observed (*n* = 151), and observations started only at dawn. In survey 3, all study households were observed, and observations took place at dawn or around noon during lunch preparation. One-hundred-thirty-nine households were observed both in surveys 2 and 3. Data were collected by teams of 10 (survey 2) and 14 (survey 3) local students and social workers of which two were female.

For all three surveys, the data collection teams were extensively trained in 3- to 4-day workshops, which included an introduction to interviewing and observation techniques, detailed discussion of the questionnaire and observation forms, role plays to practice interviews and observations, and a pre-test day to practice data collection in the field. During data collection the teams were daily accompanied and supervised by researchers and local collaborators.

8.5. Questionnaires and observation forms

The interviews were based on structured questionnaires specifically developed for the surveys. The questionnaire applied in survey 1, especially the part on social-cognitive factors, was largely based on recent work by Inauen and Colleagues (2013) and Huber et al. (2012) on water consumption in developing countries. Items were carefully adapted to handwashing behaviour and complemented with items from the only known questionnaire study on the determinants of domestic handwashing in a developing country (Aunger et al., 2010). Also, they were thoroughly adjusted to the local context of Haiti. The questionnaires used in surveys 2 and 3 were revised according to the experiences with the questionnaire used in survey 1 and adapted to the local context in Ethiopia. All questionnaires were prepared in English and were thoroughly translated to Créole or Afan Oromo, respectively, and re-translated into English to ensure the quality of the translation. For survey 2 and 3, a structured format in English was prepared for observations (Iyer, Sara, Curtis, Scott, & Cardosi, 2005). In each survey, the questionnaires’ and observation form’s applicability was verified in a pre-test. Questionnaires and observation form can be requested from the author.

8.6. Ethics statement

All surveys were conducted in strict compliance with the ethical principles of the American Psychological Association (APA), the Declaration of Helsinki, the ETH Zurich, and the ethics review guidelines of the University of Zurich. Survey 2 and 3 received favourable ethical approval from the Ethiopian National Research Ethics Review committee and the Ethics Committee of the Philosophical Faculty of University of Zurich. After survey 3 was completed, in the kebeles that had not received both theory- and evidence-based population-tailored interventions, the pending intervention(s) were implemented.

In all surveys, oral informed consent was obtained from all participants. Written consent could not be obtained due to the high illiteracy rate in the samples. Whenever a selected household refused to participate in the study, the household was thanked and the research team members left immediately.

8.7. Collaborating INGOs and NGOs

All surveys were conducted in close cooperation with international and local NGOs. First, all surveys were initiated and financed by Oxfam America. Further, survey 1 was conducted in close cooperation with employees of three affiliates of an INGO, which provided information on conducted intervention activities, facilitated field work and provided transportation. For the longitudinal studies the local Ethiopian NGO played a key role. First of all, the local NGO implemented the theory- and evidence-based population-tailored interventions. Further, they facilitated field work for surveys 2 and 3.

Therewith, the general introduction of this thesis is completed. The empirical studies that were conducted to answer the above described research questions are presented in the following Parts two to five.

Part Two

Identifying the social-cognitive determinants of handwashing: Results from two cross-sectional questionnaire studies in Haiti and Ethiopia

Nadja Contzen & Hans-Joachim Mosler

A similar version of this chapter is under review for publication.

Abstract

Background. Diarrheal disease kills around 760,000 children under five years old every year. A large part of these deaths could have been prevented by handwashing with soap at key times. However, the whole range of social-cognitive factors encouraging handwashing is not yet identified and handwashing campaigns are often limited to awareness-raising and education. The purpose of the present article is to identify the social-cognitive determinants of handwashing in Haiti (Study 1) and Ethiopia (Study 2).

Methods. Data were collected in cross-sectional surveys by administering face-to-face interviews with the primary caregiver in a participating household. In Haiti N = 811 households were surveyed, and in Ethiopia N = 463 interviews were conducted. Hierarchical multiple regression analyses were performed on stool- and food-related self-reported handwashing.

Results. In both countries, risk factors, meaning awareness and health knowledge, accounted for only 11-19% of variance in self-reported handwashing and were not consistently associated with self-reported handwashing. The inclusion of additional social-cognitive factor-groups, namely attitude factors, norm factors, ability factors, and self-regulation factors led to a significant increase in explained variance, accounting for 25–44% additionally-explained variance. In this, the attitude factor disgust, the norm factor, the ability factors motivational self-efficacy and perceived impediments, and the self-regulation factors coping planning and commitment emerged to be especially relevant in both countries.

Conclusions. These results indicate that handwashing campaigns should focus especially on attitudes and norms and not only on risk.

Keywords: Handwashing with soap · Diarrheal disease · Cholera · Behaviour change · Social-cognitive predictors · Regression analysis · Haiti · Ethiopia

Background

Diarrheal disease is one of the leading causes of death in children younger than five years old (Black et al., 2010) and one of the most common causes of death during humanitarian disasters (Wisner & Adams, 2002). These deaths are entirely preventable (World Health Organization, 2013). Infection occurs mainly through the ingestion of faecally contaminated food or water (Curtis et al., 2000). Hands are the main vector of transmission. The single most effective prevention against diarrheal disease is the seemingly simple and relatively cheap act of handwashing with soap (Cairncross et al., 2010a; for simplicity, in the following text handwashing stands for handwashing with soap). Furthermore, regular handwashing effectively lowers rates of additional infectious diseases, such as respiratory illnesses (Aiello et al., 2008) or nosocomial infections (World Health Organization, 2009).

Accordingly, handwashing campaigns are high on the agenda of development and relief organisations (see e.g. United Nations Children's Fund, 2008). However, these campaigns are hardly grounded in theory but often follow a logic model and focus on awareness-raising and knowledge-building (e.g. Global WASH Cluster, 2011; cf. Aboud & Singla, 2012; Curtis et al., 2011). This is of particular concern in the light of studies in developing countries showing that even when the majority of a population is aware of the importance of handwashing (75%–99%), only a minority (14%–36%) actually executed the desired behaviour (Steadman Group, 2007; Vivas et al., 2010). Moreover, other studies showed that educative campaigns may fail in boosting handwashing (e.g. Biran et al., 2009; Scott, Curtis, Rabie, & Garbrah-Aidoo, 2007). That is, while educative approaches might be a good starting point to promote handwashing, additional interventions might be necessary to spur regular handwashing (Aboud & Singla, 2012; Curtis et al., 2011). However, there is an incomplete picture of the factors to be intervened on; up to now, only a few scholars have addressed the determinants of nonprofessional handwashing in developing countries (Curtis et al., 2011). (Better explored are factors determining handwashing among healthcare workers; e.g. Abdella et al., 2014; Alp et al., 2011; McLaws et al., 2012).

Based on qualitative and quantitative research, one group of scholars suggested habit, motivational (e.g. disgust or attraction) and planned factors (e.g. keeping good family health) as handwashing determinants (Aunger et al., 2010). Others advocate the importance of opportunity (e.g. access and norms), ability (e.g. self-efficacy and social support) and motivational factors (e.g. attitudes and threats; Coombes & Devine, 2010). While these factors are a good starting point to investigate the drivers of handwashing, their classification lacks a comprehensive theoretical underpinning and the evidence-base remains limited.

The aim of the present article was, therefore, to identify the social-cognitive determinants of handwashing so as to enable a reflection on new and innovative handwashing campaigns in addition to awareness-raising and education. Potential determinants were derived from a recent model of behaviour change developed for the water, sanitation and hygiene sector in developing countries that integrates the social-cognitive factors proposed by major theories of behaviour change into a comprehensive model with five factor blocks, the Risk, Attitudes, Norms, Abilities, and Self-regulation of behavioural change model (the RANAS model; Mosler, 2012). These are described in the following.

Potential handwashing determinants

The first factor block, risk factors, focuses on awareness and knowledge which have an especially prominent role in the health belief model (HBM; Rosenstock, 1974). The HBM assumes that healthy behaviour is prompted specifically when people feel personally susceptible or vulnerable to a disease and perceive the disease's consequences as severe. Closely related to these factors is health knowledge, meaning knowledge about a disease's causes and symptoms and its prevention measures (cf. Albarracin et al., 2005).

In line with the theory of reasoned action (TRA; Fishbein & Ajzen, 1975), the second and third factor blocks emphasize the importance of a person's *attitudes* towards a behaviour and prevalent social *norms* related to a behaviour for a behaviour to be performed. Attitudes are a person's overall evaluation of a behaviour; it has been suggested to consider instrumental or cognitive beliefs (expected costs and benefits) as well as affective beliefs (feelings caused by thinking of or performing a behaviour) as attitudinal factors (Eagly et al., 1994; Mosler, 2012). Regarding norms, the TRA focuses on the concept of subjective or injunctive norms, that is, perceptions of which behaviours important others approve or disapprove of. Other scholars recommend adding descriptive norms, meaning perceptions of what others typically do (Rivis & Sheeran, 2003).

The fourth factor block, ability factors, follows social cognitive theory (SCT; Bandura, 1977) which states that the fundamental prerequisite of a behaviour is a personal sense of control over a behaviour. The theory's core concept is self-efficacy, defined as the belief in one's ability to initiate and execute the courses of action so that desired results are achieved (i.e. motivational self-efficacy). In addition to motivational self-efficacy, volitional self-efficacy, that is the belief in one's capability to maintain behaviour and to recover from relapse (Bandura, 1977; Schwarzer, 2008), should also be considered. Closely related to these factors is the perception of impediments also put forward by the SCT (Bandura, 2004; Schwarzer, 2008).

Lastly, the fifth factor block builds on suggestions in the health action process approach (HAPA; Schwarzer, 2008) that states that self-regulation is necessary to execute an intended behaviour. Self-regulation factors help in dealing with conflicting goals or distractions during behaviour implementation and maintenance. A central concept is coping planning, which concerns the development of plans to overcome anticipated impediments. Other scholars argue that remembering and commitment are crucial for the self-regulation of continuous behaviour performance and thus should also be considered (Mosler, 2012; Tobias, 2009).

To sum up, when exploring the determinants of handwashing behaviour, the RANAS model (Mosler, 2012), based on psychological theories of behaviour change, suggests examining risk, attitude, norm, ability, and self-regulation factors. Table 5 summarises the discussed factors and the underlying theories.

The present article depicts the results of two cross-sectional studies from Haiti and Ethiopia, which involved in-depth testing of the key factors determining self-reported handwashing behaviour. To examine if self-reported handwashing behaviour can be explained above and beyond the explanatory power of risk factors, that is awareness and knowledge, additional factors were analysed using hierarchical multiple regression, according to the blocks proposed in the RANAS model (Mosler, 2012).

Several scholars have previously emphasized the problem of inflated self-reports in terms of socially desirable behaviour, including handwashing behaviour (Biran et al., 2008; Halder et al., 2010). While self-reports are prone to reporting bias, they have been found to be associated with child diarrhoea (Luby, Halder, Huda, Unicomb, & Johnston, 2011) and child diarrhoea mortality (Water Sanitation and Hygiene Research Group, 2012), and are thus worthwhile to be studied. Self-reports are a manifestation of a person's internal behaviour representation. This internal behaviour representation, although shaped by social norms and beliefs, is a reflection of a person's actual behaviour. An intentional component, which is defining for every non-reflexive behaviour, is a core part of the representation. Thus, it is informative to examine how this intentional behaviour evolves, meaning to understand the determining social-cognitive factors, in order to identify possible behaviour change techniques.

Table 5. Overview of potential handwashing determinants specified in psychological theories and summarized in the RANAS model

		Psychological theories and models				
Factor groups	Factors	HBM	TRA	SCT	HAPA	RANAS
Risk	Vulnerability	**√**			√	√
	Severity	**√**			√	√
	Health knowledge					√
Attitudes	Instrumental beliefs	√	**√**	√	√	√
	Affective beliefs	√	√			√
Norms	Norms		**√**	√	√	√
Abilities	Motivational self-efficacy			**√**	**√**	√
	Volitional self-efficacy			√	**√**	√
	Impediments			**√**	√	
Self-regulation	Coping planning				**√**	√
	Forgetting					**√**
	Commitment					**√**

Note. HBM = Health Belief Model; TRA = Theory of Reasoned Action; SCT = Social Cognitive Theory; HAPA = Health Action Process Approach; RANAS = Risk, Attitudes, Norms, Abilities, and Self-regulation of behavioural change model. Boldface: factors which are especially emphasized within the respective theory or model or which were introduced by the respective theory or model.

Methods of the present studies

In collaboration with an international non-governmental organisation (INGO), two cross-sectional studies were conducted in Haiti and Ethiopia. For Study 1, field research was conducted in 2011 in displacement camps and poor neighbourhoods in Port-au-Prince and in rural areas in the West Department of Haiti during the recovery-phase of the disastrous earthquake and cholera outbreak in 2010. For Study 2, data were collected in 2012 in rural villages in the Borana zone of southern Ethiopia during the recovery-phase of a major drought in the Horn of Africa in 2011–2012. It should be noted that rapid onset disasters, as an earthquake, and slow onset disasters, as a drought, differ in their nature inasmuch as the former cause immediate destruction to lives and livelihoods and requires immediate help, while in the latter the threat to lives and livelihoods unfolds over a longer period, with the risk that the need for help is not recognised (Wisner et al., 2003). In the following, the methods applied in the studies are described.

Procedure

Data were obtained by means of structured face-to-face interviews with the primary caregiver in a voluntary study household. Households were selected using a modified random route sampling (Hoffmeyer-Zlotnik, 2003). For that, each camp, neighbourhood or village under study was subdivided into ten areas to which the interviewers were randomly assigned. In each area, one house was randomly selected as a starting point and the assigned interviewer was instructed to try and interview every third household when walking in a specified direction. Primary caregivers were interviewed, since they are responsible for childcare and preparing food and thus have the highest chance of spreading diarrheal disease. Also, they may act as models and therefore influence the family's hygiene behaviour. In Ethiopia, in addition, only households with at least one child younger than five were targeted as children under the age of five are most vulnerable to diarrhoea.

Interviews took around 45 minutes to one hour and were carried out in the local language (i.e. Créole in Haiti and Afan Oromo in Ethiopia) by a team of ten local students, scientists and social workers. Prior to data collection, workshops were given to train the respective team in interviewing and team members were supervised by researchers and a local field research coordinator during data collection.

Sample

For the purposes of the present studies, sample size estimation with G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009a) would have suggested to survey 400 households to detect small to medium changes in explained variance with a Type I error probability of 0.05 and a statistical power of 0.95. In the Haiti-study, however, we aimed for a larger sample size to allow the testing of additional research questions, presented elsewhere, requiring a larger sample size (Contzen & Mosler, 2013). In the Haiti-study, the achieved sample size was N = 811, with the majority of study households located in Port-au-Prince (n = 528) and a smaller sub-sample stemming from the rural areas (n = 283). The respondents' ages ranged between 15 and 90 years (M = 34.68; SD = 12.90). In terms of gender, n = 713 (88%) of the interviewees were female and n = 98 were male. While nearly half of the sample did not finish primary school (n = 395, 49%), almost a quarter did not go to school at all (n = 193, 24%). The mean income per person, per day of *M* = US $1.07 was slightly below the poverty line of US $1.25 (Ravallion, Chen, & Sangraula, 2009).

In the Ethiopia-study, a total of 463 respondents took part. The mean age of the sample was 34.27 years (*SD* = 13.89) ranging from 15 to 90 years. The vast majority was female (*n* = 450; 97%) and only *n* = 13 were male. In terms of education, 98% (*n* = 440) did not attend school at all and 97% (*n* = 449) could neither read nor write. The mean income per person, per day of *M* = US $0.17 was far below the poverty line of US $1.25 (Ravallion et al., 2009).

Questionnaire and measures

The interviews were based on structured questionnaires specifically developed for these studies. A large part of the questionnaires' items were built on recent work by Inauen and Colleagues (2013) and Huber et al. (2012). These were completed with items from the only known questionnaire study on handwashing determinants in a developing country (Aunger et al., 2010). The questionnaires covered socio-demographic characteristics, self-reported handwashing, and social-cognitive factors. They were prepared in English, translated into the respective local language, and re-translated into English to ensure the quality of the translation. In both studies the questionnaire's applicability was verified in a pre-test of *N* = 20.

Handwashing at key times was measured by means of self-reports, such as "In general, how often do you wash your hands with soap before eating?" using 5-point Likert scales ranging from 0 to 4. Surveyed key times were: handwashing after defecation, wiping a child's bottom, and other kinds of contact with stool; before eating, preparing food, feeding a child, and handling water. In Ethiopia, an additional key time was included; handwashing before breastfeeding. Exploratory factor analysis (Haiti-study) and confirmatory factor analysis (Ethiopia-study) proved that two different handwashing situations are distinguishable, stool- and food/water-related handwashing. While the former subsumes handwashing after defecation, wiping a child's bottom and other kinds of contact with stool, the latter incorporates handwashing before eating, preparing food, feeding or breastfeeding a child and handling drinking water. In both studies two mean scores were computed to represent the two factors and the scores were then used to test the handwashing drivers separately for stool-related handwashing (SRH) and food/water-related handwashing (FRH; for simplicity, in the following text, FRH stands for food- and water-related handwashing; Cronbach's alphas Haiti, α SRH = .76, α FRH = .81; Cronbach's alphas Ethiopia, α SRH = .88, α FRH = .86).

Social-cognitive factors were measured according to suggestions in the RANAS approach (Mosler, 2012). For each behavioural factor, one or more items were included in the questionnaire. If several items were used, where possible, these were combined into summary variables (see Appendix I, Tables A-1 and A-2 for item wording and Cronbach's alphas, and Tables 6 and 7 for descriptive statistics in Haiti and Ethiopia, respectively). Furthermore, 9-point Likert scales ranging from -4 to +4 were used to measure bipolar variables and 5-point Likert scales ranging from 0 to 4 were used to measure unipolar variables. In the Ethiopia-study, four factors, namely effort, time costs, and expensiveness were omitted from scale construction and analyses due to minimal variance insofar as respondents didn't find handwashing effortful, time consuming or expensive at all. Further, as handwashing facilities were non-existent in the study region in Ethiopia the item asking about the perceived distance of the handwashing facility was not applicable.

Data analyses

To select factors potentially relevant in explaining handwashing, correlations with handwashing were inspected. Due to the non-normal distribution of the behaviour measures, Spearman correlations were calculated (Bishara & Hittner, 2012). Only those factors with significant correlations were included in hierarchical multiple regression analyses to identify factors explaining handwashing above and beyond risk factors. In the first step, risk factors were included, followed by attitude, norm, ability, and self-regulation factors. To increase the estimation accuracy, the regression models were tested using bootstrap estimation with 10,000 replications. All analyses were undertaken in SPSS 22.

Informed consent and ethics statement

In both studies informed consent was obtained from all participants. The studies were conducted in strict compliance with the ethical principles of the American Psychological Association (APA) and the Declaration of Helsinki. According to the Swiss Federal law which was in force when data were collected no ethical approval was required for the two studies. In the following, the results of study 1 and study 2 are presented separately.

Table 6. Descriptive statistics for outcomes and explanatory variables, Haiti (*N* = 811)

Group	Variable	Range	*M*	*SD*	*Mdn*	Skew	Kurtosis
Outcome	Handwashing, stool-related	0−4	3.57	0.56	3.67	-1.59	3.31
	Handwashing. food-related	0−4	3.05	0.82	3.25	-0.89	0.06
Risk factors	Vulnerability	-4−4 [a]	-2.07	1.90	-3.00	1.26	1.04
	Severity	0−4 [a]	2.61	0.89	3.00	-0.77	-0.22
	Health knowledge	0−4 [a]	1.11	0.41	1.09	0.31	0.79
Attitude factors	Instrumental beliefs	-4−4 [a]	2.31	0.63	2.50	-0.61	-0.34
	Nurture	-4−4 [a]	2.83	0.98	3.00	-2.36	7.68
	Affective beliefs	-4−4 [a]	2.96	0.72	3.00	-1.88	6.67
	Disgust, stool-related	-4−4 [a]	2.38	1.84	3.00	-1.81	2.31
	Disgust, food-related	-4−4 [a]	2.57	1.57	3.00	-2.43	5.84
Norm factors	Norms, stool-related	-4−4 [a]	2.76	0.93	3.00	-1.63	2.39
	Norms, food-related	-4−4 [a]	2.76	0.90	3.00	-1.66	2.77
Ability factors	Motivational self-eff., stool-related	0−4 [a]	3.20	0.56	3.00	-0.06	0.23
	Motivational self-eff., food-related	0−4 [a]	3.16	0.59	3.00	-0.20	0.38
	Volitional self-efficacy	0−4 [a]	3.11	0.50	3.00	-0.26	3.11
	Impediments	0−4 [b]	1.04	0.70	1.00	0.60	-0.16
Self-regulation factors	Coping planning, stool-related	0−4 [a]	2.52	0.85	3.00	-0.83	-0.05
	Coping planning, food-related	0−4 [a]	2.47	0.87	3.00	-0.79	-0.07
	Forgetting, stool-related	0−4 [b]	0.67	1.00	0.00	1.46	1.52
	Forgetting, food-related	0−4 [b]	0.98	1.03	1.00	0.56	-0.88
	Commitment, stool-related	0−4 [a]	3.14	0.49	3.00	-0.15	2.88
	Commitment, food-related	0−4 [a]	3.07	0.56	3.00	-0.57	2.55

Note. [a] 4 represents an answer that is most in favour of the behaviour and 0 or -4, respectively, represent an answer that is most against the behaviour. [b] Reverse scaling.

Table 7. Descriptive statistics for outcomes and explanatory variables, Ethiopia (*N* = 463)

Group	Variable	Range	*M*	*SD*	*Mdn*	Skew	Kurtosis
Outcome	Handwashing, stool-related	0−4	2.95	0.91	3.20	-0.80	-0.34
	Handwashing, food-related	0−4	3.15	0.97	3.33	-1.08	0.02
Risk factors	Vulnerability	0−4 [a]	1.31	1.33	1.00	0.70	-0.80
	Severity	0−4 [a]	3.63	0.48	3.75	-1.64	3.19
	Health knowledge	0−4 [a]	0.99	0.45	0.99	-0.01	0.23
Attitude factors	Instrumental beliefs	0−4 [a]	3.37	0.53	3.50	-0.79	0.90
	Nurture	0−4 [a]	3.16	0.67	3.00	-1.12	1.82
	Affective beliefs	-4−4 [a]	3.66	0.63	4.00	-3.48	17.93
	Disgust, stool-related	-4−4 [a]	3.28	0.90	3.00	-1.99	4.91
	Disgust, food-related	-4−4 [a]	3.28	0.73	3.00	-1.53	4.83
Norm factors	Norms, stool-related	-4−4 [a]	2.79	0.85	3.00	-1.43	2.62
	Norms, food-related	-4−4 [a]	2.82	0.82	3.00	-1.13	1.44
Ability factors	Motivational self-eff., stool-related	0−4 [a]	3.01	0.85	3.00	-1.64	4.21
	Motivational self-eff., food-related	0−4 [a]	3.02	0.83	3.00	-1.73	4.66
	Volitional self-efficacy	0−4 [a]	2.28	1.18	2.75	-0.53	-0.99
	Impediments	[b, c]	1.04	1.33	0.67	1.65	3.51
Self-regulation factors	Coping planning	0−4 [a]	0.77	0.80	0.83	0.71	-0.41
	Forgetting	[b, c]	0.73	1.39	0.00	2.97	15.02
	Commitment, stool-related	0−4 [a]	3.08	0.80	3.00	-0.88	1.31
	Commitment, food-related	0−4 [a]	3.11	0.75	3.00	-0.96	2.27

Note. [a] 4 represents an answer that is most in favour of the behaviour and 0 or -4, respectively, represent an answer that is most against the behaviour. [b] Reverse scaling. [c] Response categories are the natural numbers.

Study 1: Handwashing determinants in Haiti

Results

The median level of self-reported handwashing was rather high, with *Mdn* = 3.67 in SRH and *Mdn* = 3.25 in FRH. Spearman correlations revealed that only severity was not significantly associated with SRH and FRH (see Table 8). This factor was omitted from regression analyses. Surprisingly and counter-intuitively, correlation analyses also revealed that health knowledge and vulnerability were negatively associated with both types of handwashing.

Table 8. Spearman correlations for SRH (below diagonal) and FRH (above diagonal) and explanatory variables, Haiti

	Spearman correlations														
Variable	HW	VUL	SEV	HKNO	INST	NURT	AFFE	DISG	NORM	MS	VOLS	IMP	COPP	FORG	COM
HW		**-0.29**	0.03	**-0.22**	**0.37**	**0.32**	**0.43**	**0.35**	**0.44**	**0.38**	**0.14**	**-0.44**	**0.45**	**-0.45**	**0.39**
VUL	**-0.20**		0.05	0.02	**-0.20**	**-0.16**	**-0.27**	**-0.25**	**-0.24**	**-0.26**	**-0.08**[b]	**0.24**	**-0.28**	**0.20**	**-0.25**
SEV	-0.02	0.05		0.02	**-0.08**[b]	-0.02	-0.02	0.00	0.00	0.04	0.06	**0.08**[b]	**-0.07**[b]	**0.09**[a]	0.02
HKNO	**-0.28**	0.02	0.02		**-0.14**	**-0.24**	**-0.26**	**-0.25**	**-0.16**	**-0.21**	0.05	**0.13**	**-0.17**	**0.15**	**-0.26**
INST	**0.27**	**-0.20**	**-0.08**[b]	**-0.14**		**0.28**	**0.33**	**0.32**	**0.37**	**0.37**	**0.13**	**-0.29**	**0.36**	**-0.30**	**0.34**
NURT	**0.31**	**-0.15**	-0.02	**-0.24**	**0.28**		**0.42**	**0.26**	**0.29**	**0.38**	**0.14**	**-0.22**	**0.34**	**-0.28**	**0.38**
AFFE	**0.34**	**-0.26**	-0.01	**-0.26**	**0.33**	**0.42**		**0.38**	**0.40**	**0.41**	**0.15**	**-0.26**	**0.41**	**-0.34**	**0.40**
DISG	**0.42**	**-0.19**	0.03	**-0.27**	**0.35**	**0.46**	**0.45**		**0.29**	**0.36**	**0.15**	**-0.19**	**0.27**	**-0.21**	**0.37**
NORM	**0.33**	**-0.24**	0.00	**-0.16**	**0.35**	**0.28**	**0.40**	**0.36**		**0.35**	**0.09**[b]	**-0.39**	**0.32**	**-0.40**	**0.33**
MS	**0.33**	**-0.24**	0.03	**-0.15**	**0.29**	**0.36**	**0.38**	**0.41**	**0.26**		**0.21**	**-0.23**	**0.41**	**-0.26**	**0.50**
VOLS	**0.11**[a]	**-0.08**[b]	0.06	0.05	**0.14**	**0.15**	**0.15**	**0.12**[a]	**0.07**[b]	**0.26**		**-0.08**[b]	**0.18**	**-0.10**[a]	**0.20**
IMP	**-0.37**	**0.24**	**0.08**[b]	**0.14**	**-0.29**	**-0.21**	**-0.26**	**-0.29**	**-0.36**	**-0.20**	**-0.08**[b]		**-0.33**	**0.40**	**-0.24**
COPP	**0.35**	**-0.29**	**-0.07**[b]	**-0.13**	**0.33**	**0.37**	**0.41**	**0.40**	**0.33**	**0.37**	**0.18**	**-0.32**		**-0.31**	**0.40**
FORG	**-0.34**	**0.20**	**0.10**[a]	**0.15**	**-0.30**	**-0.28**	**-0.33**	**-0.35**	**-0.38**	**-0.24**	**-0.09**[b]	**0.40**	**-0.32**		**-0.30**
COM	**0.31**	**-0.14**	0.06	**-0.12**[a]	**0.17**	**0.24**	**0.28**	**0.29**	**0.17**	**0.38**	**0.23**	**-0.18**	**0.27**	**-0.15**	

Note. *N* SRH = 806; *N* FRH = 800. HW = handwashing; VUL = vulnerability; SEV = severity; HKNO = health knowledge; INST = instrumental beliefs; NURT = nurture; AFFE = affective beliefs; DISG = disgust; NORM = norms; MS = motivational self-efficacy; VOLS = volitional self-efficacy; IMP = impediments; COPP = coping planning; FORG = forgetting; COM = commitment. Boldface: significant with $p < .001$, except for the following: [a] $p < .01$; [b] $p < .05$.

Table 9 presents the hierarchical regression results for SRH. Risk factors accounted for 11% of the variance in SRH. By including the additional factor groups, in each step, the amount of explained variance increased significantly. The final model explained 36% of the variance, that is, 25% more than risk factors only. The explained variance in SRH in the final model corresponds to an effect size of $f^2 = 0.56$, which is a large effect (Cohen, 1992).

To assess the factors' relative explanatory power, the effect sizes (i.e. standardized regression coefficients) in this last model were consulted. The best explanatory variables were coping planning (β = .18), commitment (β = .14), and the attitude factor of disgust (β = .12). In addition, significant explanatory power in the expected direction was found for norms (β = .09), motivational self-efficacy (β = .11), impediments (β = -.11), and forgetting (β = -.07). However, counter-intuitively, albeit corresponding with correlation results (see above), *higher* levels in knowledge were related significantly with *lower* levels in handwashing (β = -.13).

Table 9. Hierarchical multiple regression analysis explaining self-reported SRH in Haiti (*N* = 807)

					Model 5	
Predictors	Model 1 *B*	Model 2 *B*	Model 3 *B*	Model 4 *B*	*B*	90% CI for *B*
(Constant)	3.99 ***	3.03 ***	2.96 ***	2.80 ***	2.53 ***	[2.20, 2.86]
Vulnerability	-0.03 **	-0.02 *	-0.01	0.00	0.00	[-0.01, 0.01]
Severity[a]	–	–	–	–	–	
Health knowledge	-0.42 ***	-0.21 ***	-0.19 ***	-0.18 **	-0.17 **	[-0.26, -0.09]
Instrumental beliefs		0.10 **	0.06 *	0.03	0.01	[-0.03, 0.06]
Nurture		0.05 **	0.05 **	0.04 *	0.03	[0.00, 0.06]
Affective beliefs		0.07 *	0.04	0.02	-0.01	[-0.04, 0.03]
Disgust		0.08 ***	0.06 ***	0.05 **	0.03 **	[0.01, 0.06]
Norms			0.10 ***	0.07 **	0.05 *	[0.01, 0.09]
Motivation self-eff.				0.16 ***	0.10 **	[0.04, 0.15]
Volitional self-efficacy				0.02	-0.01	[-0.06, 0.05]
Impediments				-0.11 ***	-0.08 **	[-0.12, -0.04]
Coping planning					0.11 ***	[0.07, 0.15]
Forgetting					-0.04 *	[-0.07, 0.00]
Commitment					0.15 ***	[0.08, 0.22]
R^2	.11	.26	.28	.31	.36	
F	52.08***	47.91***	45.43***	38.12***	35.36***	
ΔR^2		.15	.02	.04	.04	
ΔF		40.62***	22.71***	15.33***	17.91***	

Note. CI = confidence interval. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$. [a] Variable excluded due to insignificant correlation with SRH.

Regarding FRH, risk factors accounted for 12% of the variance (see Table 10). Again, the explained variance increased significantly with each additional step. In the final model, 56% of the variance was explained, thus 44% more than for risk factors alone. The explained variance in FRH in the final model corresponds to an effect size of f^2 = 1.27, which is a large effect (Cohen, 1992).

Regarding the factors' effect sizes coping planning (β = .22) was the most important explanatory variable, followed by norms (β = .17) and impediments (β = -.16). Furthermore, there was significant explanatory power in the expected direction for the instrumental beliefs (β = .06), the affective beliefs (β = .09), the attitude factor of disgust (β = .05), motivational self-efficacy (β = .10), forgetting (β = -.13), and commitment (β = .09). Neither vulnerability nor health knowledge had significant explanatory power in either direction.

Table 10. Hierarchical multiple regression analysis explaining self-reported FRH in Haiti (*N* = 807)

					Model 5	
Predictors	Model 1 *B*	Model 2 *B*	Model 3 *B*	Model 4 *B*	*B*	90% CI for *B*
(Constant)	3.47 ***	1.00 ***	0.81 ***	0.82 ***	0.92 ***	[0.56, 1.29]
Vulnerability	-0.10 ***	-0.05 **	-0.04 **	-0.02	-0.01	[-0.03, 0.01]
Severity[a]	–	–	–	–	–	–
Health knowledge	-0.55 ***	-0.21 **	-0.13 *	-0.10	-0.06	[-0.15, 0.03]
Instrumental beliefs		0.37 ***	0.22 ***	0.13 **	0.08 **	[0.01, 0.15]
Nurture		0.10 ***	0.08 **	0.05 **	0.03	[0.00, 0.07]
Affective beliefs		0.32 ***	0.21 ***	0.16 ***	0.10 **	[0.04, 0.16]
Disgust		0.04 *	0.03 *	0.02 *	0.03 *	[0.01, 0.05]
Norms			0.33 ***	0.23 ***	0.16 ***	[0.10, 0.22]
Motivation self-eff.				0.24 ***	0.13 **	[0.06, 0.20]
Volitional self-efficacy				0.05	0.01	[-0.06, 0.08]
Impediments				-0.24 ***	-0.18 ***	[-0.24, -0.13]
Coping planning					0.21 ***	[0.15, 0.27]
Forgetting					-0.11 ***	[-0.15, -0.06]
Commitment					0.13 *	[0.06, 0.21]
R^2	.12	.36	.45	.50	.56	
F	54.37***	77.00***	92.74***	81.06***	77.50***	
ΔR^2		.25	.08	.06	.05	
ΔF		77.81***	118.55***	29.97***	32.84***	

Note. CI = confidence interval. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$. [a] Variable excluded due to insignificant correlation with handwashing.

Discussion

Consistent with our expectations, attitude, norm, ability, and self-regulation factors explained SRH and FRH above and beyond risk factors. Moreover, the risk factors of vulnerability and health knowledge were significantly *negatively* correlated with SRH and FRH (though having only limited explanatory power), and severity was *un*correlated with both behaviours. Similarly, previous studies have stated mixed results in terms of knowledge and threat (a combination of vulnerability and severity) and handwashing (Aunger et al., 2010; Biran et al., 2009; Devine et al., 2012) and between vulnerability and various health behaviours (Norman et al., 2009; see general discussion for more details).

These findings emphasise the urgent need for additional handwashing campaigns that tackle additional aspects other than risk factors. To decide which factors should be targeted, the amount of variance explained by a factor group and the effect size of a single factor are instructive. Supporting the TRA (Fishbein & Ajzen, 1975), the inclusion of the attitude factors led to the highest increase in explained variance. However, this is qualified by the fact that these factors had a higher likelihood of explaining variance in handwashing since they were entered in the second step and because they were more numerous than the other factors. Underpinning TRA (Fishbein & Ajzen, 1975), SCT (Bandura, 1977) and HAPA (Schwarzer, 2008), most important in terms of the effect sizes were attitudes (i.e. disgust), norms, abilities (i.e. impediments) and self-regulation factors (i.e. coping planning and commitment). All in all, the results suggest that when designing handwashing campaigns, attitude, norm, ability and self-regulation factors should be tackled in addition to risk factors.

To obtain further empirical evidence on the determinants of handwashing and to test the factors in a different cultural, social, and situational context, Study 2 was conducted.

Study 2: Handwashing determinants in Ethiopia

Results

On average, respondents reported washing their hands rather frequently, with median levels of *Mdn* = 3.20 for SRH and *Mdn* = 3.33 for FRH. Table 11 shows that only one factor, health knowledge, was uncorrelated with handwashing. Thus, the factor was omitted from subsequent analyses. Surprisingly and counter-intuitively, correlation analyses also revealed that vulnerability was negatively associated with both types of handwashing.

Table 11. Spearman correlations for SRH (below diagonal) and FRH (above diagonal) and explanatory variables, Ethiopia (*N* = 462)

Variable	HW	VUL	SEV	HKNO	INST	NURT	AFFE	DISG	NORM	MCS	VOLS	IMP	COPP	FORG	COM
HW		**-0.13**[a]	**0.36**	0.06	**0.19**	**0.32**	**0.16**[a]	**0.14**[a]	**0.59**	**0.19**	**0.25**	**-0.37**	**0.20**	**-0.36**	**0.26**
VUL	**-0.25**		-0.08	**0.11**[b]	0.08	**0.12**[b]	-0.07	0.02	**-0.21**	-0.01	**-0.30**	**0.14**[a]	**-0.13**[a]	**0.12**[b]	-0.05
SEV	**0.33**	-0.09		**0.21**	**0.32**	**0.31**	**0.29**	**0.26**	**0.25**	0.07	-0.01	**-0.25**	-0.03	**-0.21**	0.06
HKNO	0.00	**0.10**[b]	**0.21**		**0.13**[a]	-0.05	**0.19**	**0.14**[a]	**-0.11**[b]	-0.03	**-0.12**[b]	-0.09	**0.15**[a]	-0.09	-0.07
INST	**0.23**	0.08	**0.32**	**0.14**[a]		**0.45**	**0.16**[a]	**0.25**	**0.20**	**0.13**[a]	**0.14**[b]	**-0.13**[a]	0.03	**-0.15**[a]	**0.21**
NURT	**0.38**	**0.12**[b]	**0.30**	-0.05	**0.45**		**0.12**[a]	**0.23**	**0.22**	**0.24**	**0.13**[b]	**-0.09**[b]	-0.07	**-0.13**[a]	**0.30**
AFFE	**0.16**	-0.08	**0.29**	**0.19**	**0.16**[a]	**0.12**[a]		**0.19**	**0.20**	0.02	0.02	**-0.15**[a]	**0.09**[b]	**-0.17**	0.00
DISG	**0.34**	**-0.09**[b]	**0.36**	**0.12**[a]	**0.21**	**0.31**	**0.23**		0.02	**0.16**[a]	**-0.13**[b]	**-0.10**[b]	-0.07	-0.08	**0.15**[a]
NORM	**0.57**	**-0.22**	**0.21**	-0.07	**0.16**	**0.20**	**0.18**	**0.17**		**0.11**[b]	**0.40**	**-0.24**	**0.21**	**-0.27**	**0.36**
MCS	**0.28**	-0.04	0.05	-0.05	**0.12**[b]	**0.22**	0.00	**0.18**	**0.13**[a]		0.00	**-0.09**[b]	0.02	**-0.15**[a]	**0.29**
VOLS	**0.28**	**-0.30**	-0.02	**-0.13**[b]	**0.14**[b]	**0.13**[b]	0.02	0.05	**0.43**	0.01		**-0.22**	**0.46**	**-0.19**	**0.24**
IMP	**-0.34**	**0.15**[a]	**-0.25**	-0.09	**-0.13**[a]	**-0.10**[b]	**-0.15**	**-0.16**[a]	**-0.24**	-0.07	**-0.22**		**-0.14**[a]	**0.57**	**-0.14**[a]
COPP	**0.21**	**-0.13**[a]	-0.04	**0.14**[a]	0.03	-0.06	**0.09**[b]	0.03	**0.27**	0.01	**0.46**	**-0.14**[a]		**-0.15**[a]	0.03
FORG	**-0.34**	**0.12**[a]	**-0.21**	-0.09	**-0.15**[a]	**-0.13**[a]	**-0.18**	**-0.22**	**-0.29**	**-0.13**[a]	**-0.19**	**0.58**	**-0.15**[a]		**-0.21**
COM	**0.38**	-0.09	**0.13**[a]	**-0.13**[a]	**0.23**	**0.35**	0.09	**0.26**	**0.35**	**0.26**	**0.24**	**-0.16**[a]	0.01	**-0.19**	

Note. N SRH = 462; *N* FRH = 460. HW = handwashing; VUL = vulnerability; SEV = severity; HKNO = health knowledge; INST = instrumental beliefs; NURT = nurture; AFFE = affective beliefs; DISG = disgust; NORM = norms; MCS = motivational self-efficacy; VOLS = volitional self-efficacy; IMP = impediments; COPP = coping planning; FORG = forgetting; COM = commitment. Boldface: significant with $p < .001$, except for the following: [a] $p < .01$; [b] $p < .05$.

In Table 12, hierarchical multiple regression results are displayed for SRH. Risk factors explained 19% of the variance in SRH. The amount of explained variance increased significantly by entering the additional factor groups. The final model accounted for 52% of the variance, that is, 32% more than risk factors alone. The explained variance in SRH in the final model corresponds to an effect size of f^2 = 1.08, which is a large effect (Cohen, 1992).

With regard to behavioural factor, the effect sizes in this last model revealed that the attitude factor of nurture (β = .33) was the best explanatory variable, followed by norms (β = .32) and severity (β = .19). In addition, the attitude factor of disgust (β = .07), the ability factors, motivational self-efficacy (β = .10) and impediments (β = -.14), and the self-regulation factors, coping planning (β = .11) and commitment (β = .12) had significant explanatory power in the expected direction.

Table 12. Hierarchical multiple regression analysis explaining self-reported SRH in Ethiopia (*N* = 458)

					Model 5	
Predictors	Model 1 *B*	Model 2 *B*	Model 3 *B*	Model 4 *B*	*B*	90% CI for *B*
(Constant)	0.19	-0.87 *	-1.35 ***	-1.24 **	-1.32 **	[-2.00, -0.65]
Vulnerability	-0.08 **	-0.11 ***	-0.06 *	-0.03	-0.03	[-0.08, 0.01]
Severity	0.85 ***	0.41 ***	0.40 ***	0.36 ***	0.38 ***	[0.23, 0.51]
Health knowledge[a]	–	–	–	–	–	–
Instrumental beliefs		0.10	0.05	0.01	-0.01	[-0.14, 0.12]
Nurture		0.55 ***	0.52 ***	0.49 ***	0.48 ***	[0.37, 0.59]
Affective beliefs		0.07	-0.07	-0.05	-0.06	[-0.14, 0.03]
Disgust		0.10 *	0.13 **	0.10 *	0.07 *	[0.00, 0.14]
Norms			0.41 ***	0.39 ***	0.36 ***	[0.27, 0.44]
Motivation self-eff.				0.15 ***	0.12 **	[0.05, 0.18]
Volitional self-efficacy				-0.01	-0.05	[-0.11, 0.00]
Impediments				-0.12 ***	-0.10 **	[-0.17, -0.04]
Coping planning					0.13 ***	[0.07, 0.20]
Forgetting					-0.02	[-0.07, 0.05]
Commitment					0.15 **	[0.06, 0.23]
R^2	.19	.35	.46	.51	.52	
F	54.59***	41.25***	57.55***	48.17***	39.67***	
ΔR^2		.16	.12	.05	.02	
ΔF		28.08***	100.68***	14.33***	5.97**	

Note. CI = confidence interval. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$. [a] Variable excluded due to insignificant correlation with SR.

Results for FRH are presented in Table 13. Risk factors accounted for 19% of the variance in FRH. Again, the explained variance increased significantly with each additional step. In the final model, 50% of the variance was accounted for, which was 31% more than with risk factors only. The explained variance in SRH in the final model corresponds to an effect size of $f^2 = 1.00$, which is a large effect (Cohen, 1992).

With regard to the factors relative importance (i.e. effect sizes) the most important explanatory variable was the norm factor (β = .42), followed by the attitude factor of nurture (β = .26) and severity (β = .23). In addition, significant explanatory power in the expected direction was found for the attitude factor of disgust (β = .07); for the ability factors motivational self-efficacy (β = .07) and impediments (β = -.09); and for the self-regulation factors coping planning (β = .08) and forgetting (β = -.12).

Table 13. Hierarchical multiple regression analysis explaining self-reported FRH in Ethiopia (N = 460)

					Model 5	
Predictors	Model 1 *B*	Model 2 *B*	Model 3 *B*	Model 4 *B*	*B*	90% CI for *B*
(Constant)	0.06	-0.81 **	-1.31 ***	-1.07 **	-0.99 **	[-1.66, -0.38]
Vulnerability	-0.05	-0.07 **	-0.02	0.00	0.00	[-0.04, 0.04]
Severity	0.81 ***	0.51 ***	0.46 ***	0.42 ***	0.42 ***	[0.30, 0.55]
Health knowledge[a]	–	–	–	–	–	–
Instrumental beliefs		0.02	-0.06	-0.10	-0.11	[-0.23, 0.01]
Nurture		0.40 ***	0.37 ***	0.35 ***	0.35 ***	[0.26, 0.45]
Affective beliefs		0.10 *	-0.05	-0.04	-0.05	[-0.14, 0.04]
Disgust		0.08	0.13 **	0.10 *	0.09 *	[0.01, 0.17]
Norms			0.50 ***	0.47 ***	0.46 ***	[0.39, 0.55]
Motivation self-eff.				0.11 **	0.08 *	[0.01, 0.15]
Volitional self-efficacy				0.00	-0.03	[-0.08, 0.02]
Impediments				-0.11 ***	-0.06 *	[-0.13, -0.01]
Coping planning					0.09 **	[0.03, 0.15]
Forgetting					-0.08 *	[-0.13, 0.00]
Commitment					0.04	[-0.05, 0.13]
R^2	.19	.28	.45	.48	.50	
F	54.40***	30.04***	54.01***	43.73***	35.50***	
ΔR^2		.09	.17	.04	.02	
ΔF		14.60***	141.56***	11.18***	4.56**	

Note. CI = confidence interval. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$. [a] Variable excluded due to insignificant correlation with handwashing.

Discussion

In parallel with the results from the Haiti study, in Ethiopia, SRH and FRH were explained above and beyond risk factors by attitude, norm, ability, and self-regulation factors. While health knowledge was not associated with handwashing, vulnerability was again negatively correlated with handwashing without having explanatory power. Severity, however, was positively related with handwashing and explained it significantly with a comparatively high effect size.

Notwithstanding, the results suggest again that handwashing campaigns should not be limited to risk factors but instead should target additional factors as well. Attitudes and norms, included at the second and third step, contributed the most to an increase in explained variance above and beyond risk factors. Moreover, genuinely underpinning the TRA (Fishbein & Ajzen, 1975), the attitude factor of nurture and the norm factor had some of the highest effect sizes with regard to both types of handwashing. The ability factors (i.e. motivational self-efficacy and impediments), and the self-regulation factor of coping planning were relevant for both types of handwashing, which lends support to the SCT (Bandura, 1977) and the HAPA (Schwarzer, 2008).

General discussion

Summary and interpretation of results

The results of the two studies demonstrate that risk factors alone are not sufficient to explain handwashing behaviour. In fact, risk factors were sometimes unrelated, sometimes positively, and sometimes even negatively related with handwashing. Correspondingly, previous formative research showed that a perceived threat is a cause for handwashing during cholera epidemics only (Aunger et al., 2010). Moreover, there is evidence that mothers with higher threat levels are less likely to have a designated place for handwashing, which is a proxy for handwashing behaviour (Devine et al., 2012). Vulnerability, consistently negatively associated with both types of handwashing in both Haiti and Ethiopia, was shown to be negatively correlated with various health behaviours, such as exercising or cancer screening (Norman et al., 2009). In terms of knowledge, although no negative correlations are known, previous studies have revealed a mixed pattern, with some studies indicating a positive association with handwashing and others finding no association (e.g. Biran et al., 2009; Devine et al., 2012). There are two explanations for this found negative association. First, it might reflect that for respondents with higher levels of knowledge, self-report of behaviour is more accurate, as they are more aware of the indications and opportunities for handwashing. Alternatively, the negative association might also reflect participants' abandonment of preventive actions. Diarrhoea is transmitted through several paths; handwashing neglect is only one potential cause and handwashing compliance is only one preventive measure. Knowledge was measured by asking for the causes and effects of diarrhoea and its preventive measures. High knowledge might thus reflect that respondents are more aware of the multiple causes and multiple preventive measures, which have to be taken. However, the respondents might not feel capable to actually engage in all these preventive actions and thus, abandon the efforts. This latter interpretation is in line with research showing that fear (which might be aroused by relevant health knowledge) results only in protective behaviour when there is confidence in the own ability to perform the protective behaviour (i.e. high self-efficacy belief; see Bartholomew et al., 2006). The association between health knowledge and handwashing behaviour should be further investigated; thereby, it should be controlled for self-efficacy beliefs with regard to all preventive measures.

These inconclusive results related to risk factors question the explanatory power of theories primarily emphasizing the importance of risk factors in regard to handwashing, such as the HBM (Rosenstock, 1974). Additional factors are needed to explain handwashing adequately and these should also be targeted in campaigns.

As to the first factor group specified in the TRA (Fishbein & Ajzen, 1975), attitudes, our results indicate that the surveyed instrumental beliefs were of varying importance. The instrumental beliefs-scale did not have any explanatory power in Haiti or in Ethiopia. However, nurture had ample relevance in terms of explaining handwashing in Ethiopia. That means that respondents who reported washing their hands to keep their children healthy and to educate them in correct behaviour tended to wash their hands more often than respondents to whom handwashing was not such a matter of nurture. This result supports findings from formative studies in which nurture was often mentioned as a reason for handwashing (Aunger et al., 2010).

Similarly, the affective beliefs-scale was of minor importance, while disgust had consistent explanatory power in both countries, meaning that respondents who believed that it is disgusting not to wash hands after defecation or before handling food tended to wash their hands more often than others. In line with this are findings from formative, survey and experimental studies, all of which emphasised the importance of disgust in triggering handwashing (Aunger et al., 2010; Porzig-Drummond et al., 2009).

Norms, the second factor group put forward in the TRA (Fishbein & Ajzen, 1975), were of major relevance in both countries. That is, respondents who thought that people in their surroundings often wash their hands and felt that significant others expect them to wash their hands, tended to wash their hands more often than others. Similar conclusions about the importance of these norms have been drawn in formative, observational, survey and experimental handwashing studies (Aunger et al., 2010; Devine et al., 2012; Drankiewicz & Dundes, 2003; Judah et al., 2009).

Turning to ability factors, motivational self-efficacy was relevant in terms of both behaviours in both countries, what lends support to SCM (Bandura, 1977). In other words, respondents who felt able to wash their hands at all required times tended to wash their hands more often than those who felt unable to do so. In contrast to HAPA's assumptions (Schwarzer, 2008), volitional self-efficacy was irrelevant. Impediments, however, were crucial for both types of handwashing in both countries, meaning that people who felt hindered in handwashing tended to wash their hands less often than those who did not feel hindered. This is in line with SCM (Bandura, 2004) and previous research on handwashing showing that the antipole to impediments, which is access, determines handwashing (Devine et al., 2012).

Regarding self-regulation, giving some support to the HAPA (Schwarzer, 2008), coping planning was essential in both countries for both behaviours. That is, respondents who had specific plans for how to deal with impediments tended to wash their hands more often than those without such plans. Commitment also had explanatory power in both countries, although not for FRH in Ethiopia, meaning that respondents who felt committed to washing their hands tended to wash their hands more often at the specific times. Similarly, forgetting was relevant in both countries except for SRH in Ethiopia. That is respondents who stated they did not forget handwashing tended to wash their hands more often. To our knowledge, there are no previous handwashing studies looking at self-regulation factors, and so these results could not be compared.

The studies further revealed that one can distinguish between SRH and FRH. The variance in both types of handwashing was substantially explained by the tested factors. However, even though some factors explained SRH and FRH equally well, there are factors explaining only one behaviour or with differing power. This is in line with findings from previous research on SRH and FRH in Kenya (2010).

In conclusion, risk factors were revealed to be rather inconsistently related with handwashing. This finding questions the current status quo of handwashing campaigns, which focus on awareness and knowledge. Instead, handwashing was consistently explained in both countries by the attitude factor disgust, norms, motivational self-efficacy, perceived impediments, coping planning, and commitment. These factors should be tackled additionally in promotional activities.

Practical Implications

Our findings highlight the necessity of applying additional interventions to awareness-raising and education in order to tackle those factors most important in explaining handwashing. To determine appropriate interventions, the RANAS model can be consulted (Mosler, 2012). It provides a framework ascribing intervention techniques to each factor group. To spur the emotion of disgust, for instance, affective persuasion is indicated. That is, aversion has to be attached to the unhealthy behaviour of not washing hands by demonstrating, for example, that not washing hands after defecation and before eating eventually means eating stool. To strengthen norms, norms which already exist or which do not exist yet, can be highlighted by referencing to important others, to other communities, other regions, or even other countries that apparently wash their hands frequently. To heighten motivational self-efficacy, behavioural interventions that strengthen ability beliefs and optimise infrastructure are necessary. That is, beneficiaries should be encouraged to tackle impediments (see next paragraph), and where not present yet, handwashing facilities could be constructed at critical junctions, such as next to latrines and cooking places. To lower impediments, people should be motivated to identify them and to develop detailed but realistic plans to counter them (Mosler, 2012; Schwarzer, 2008). Thus, people could be invited to fill out a form where they specify when exactly during the day they refill the handwashing facility with water and when they check if they are short of soap and where they obtain water and soap.

The studies demonstrated that handwashing drivers partly differ between behaviour (SRH and FRH) and especially between countries. Accordingly, to be effective, handwashing campaigns must be tailored to the specific behaviour and the country in which the behaviour needs to be changed. Therefore, there is an inevitable need to select handwashing promotions population-tailored, i.e. to conduct a baseline survey assessing handwashing determinants prior to every intervention and to select the interventions according to the baseline results.

At the same time, within the context of an emergency situation, relief organisations often lack the time to conduct baseline surveys and help has to be administered immediately. Since diarrhoea risk tends to increase during disasters, this is true for handwashing campaigns that are conducted right from the beginning of emergency interventions. Consequently, relief organisations are in need of a campaign package suitable in every social or cultural context. The presented results are a first step in this direction, as they specify drivers of handwashing that are relevant across two cultures.

Strengths, limitations and perspectives for future research

To our knowledge, this is the first study that comprehensively explores the social-cognitive determinants of nonprofessional handwashing in developing countries based on theories of behaviour change. Previous studies have covered only a set of factors but have never concurrently tested the whole range of factors specified in relevant theories. Only by doing the latter is it possible to assess the *relative* importance of social-cognitive handwashing determinants.

While the present paper focused on social-cognitive determinants of handwashing, a recent behavioural model for water, sanitation, and hygiene (Dreibelbis et al., 2013) which was published after the present studies had been conducted suggests also considering contextual and technology factors. Some of these factors were covered in the present studies by the factors instrumental beliefs (e.g. perceived costs) and impediments (e.g. lack of water or soap). However, additional contextual factors such as climate or access to water that certainly limits the amount of water available for handwashing and additional technology factors such as location, access and physical characteristics of a potentially used handwashing station might be crucial facilitators or impediments to handwashing. Future studies should test these factors as determinants of handwashing but also as moderating factors and as antecedents of the social-cognitive determinants.

To survey the whole range of potential social-cognitive factors in a questionnaire of reasonable length, single variables had to be measured with only a few items, or sometimes with only one item. This is problematic in terms of reliability. Still, the variables that were measured using several items showed acceptable alpha values.

Both studies were cross-sectional, generating correlational data. From that, no causal conclusions can be drawn. To draw causal conclusions in the future, longitudinal or experimental studies are necessary.

Self-reported handwashing behaviour is said to be overestimated due to socially desirable answer tendencies (Biran et al., 2008; Halder et al., 2010). Consequently, it has been suggested to observe the behaviour instead. In the present studies, however, due to feasibility issues, behavioural data had to be collected by means of self-reports. Nevertheless, self-reports reflect an internal behaviour representation that is associated with child diarrhoea and child diarrhoea mortality (Luby, Halder, Huda, Unicomb, et al., 2011; Water Sanitation and Hygiene Research Group, 2012), and are therefore worthwhile to examine. Looking at its determinants provides essential information about the formation of this intentional behaviour. Still, validation of the results by means of observational data would be preferable.

Not all variables were measured identically in Haiti and Ethiopia. Sometimes, language or cultural specifics impeded identical wording. As a consequence, some caution is advisable when comparing the results. Still, it was insightful to test potential handwashing drivers in two different cultural and social contexts (see below for further information).

In both Haiti and Ethiopia, data were collected in the recovery phase of an emergency. It is conceivable that an emergency situation affects the relevance of social-cognitive factors. For instance, during an emergency situation, people may feel more vulnerable to communicable diseases or act predominantly out of vulnerability concerns, self-efficacy beliefs could be lowered due to a lack in infrastructure, or perceived costs of goods could be inflated due to financial difficulties. Consequently, the studies' results should not be generalised to development (nor acute emergency) situations without any cautions.

Conclusions

As one of the first articles examining the social-cognitive determinants of nonprofessional handwashing in developing countries, the present studies provide important new evidence on the potential targets of handwashing campaigns. Based on the results, it is possible to say that if a standard framework for handwashing campaigns had to be developed, it should not focus only on risk factors, meaning awareness and knowledge. More importantly, it should also target the following: attitude factors, such as nurture or disgust; norm factors; ability factors, such as motivational self-efficacy and perceived impediments; and self-regulation factors, i.e. coping planning, forgetting and commitment. However, more research in different cultures and contexts is needed to build a better evidence-base in order to develop a much-needed standard framework for emergency handwashing interventions.

Additional information

Appendix I contains additional information about the social-cognitive factors' item wording and Cronbach's alphas separately for study 1 and study 2.

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Part Three

Impact of different promotional channels on handwashing behaviour in an emergency context: Haiti post-earthquake public health promotions and cholera response

Nadja Contzen & Hans-Joachim Mosler

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Abstract

Aim. In a disaster context, where risk for diarrhoeal disease is elevated, personal hygiene, i.e. handwashing with soap, is especially relevant. However, to date, the promotion of hygiene in an emergency context has not been adequately addressed in the literature. The aim of the present study is to evaluate the effectiveness of hygiene promotions in post-earthquake Haiti.

Methods. Cross-sectional data was collected by means of structured interviews in camps and neighbourhoods in which three affiliates of a well-known relief organisation had conducted hygiene promotions. Primary caregivers were targeted. A total sample of 811 was obtained. Data was analysed using multiple linear regression and mediation analysis.

Results. Analyses revealed six promotional channels with positive associations with handwashing behaviour: hygiene radio spots, radio programs with experts answering listener's questions, material distributions with instructions for use, information from friends or neighbours, hygiene theatres, and community clubs. However, five of the promotional channels were negatively related with handwashing. Respondents who experienced a focus group, stickers, posters and paintings, hygiene songs, special hygiene days and home visits tended to wash their hands less often.

Conclusions. By revealing positive but also negative associations between hygiene promotions and handwashing behaviour, the study underlines the need to apply theory-driven emergency hygiene promotions which are subjected to in-depth evaluation. Only through doing this, it is ensured that effective hygiene promotions are implemented for the most vulnerable people – those affected by a humanitarian disaster.

Keywords: Handwashing with soap · Diarrhoea · Hygiene Promotion · Communication Channels · Emergency · Haiti

Introduction

On January 12, 2010, a 7.0 magnitude earthquake hit Haiti and killed an estimated 220,000 people and injured 300,000 (Pan American Health Organization & World Health Organization, 2011). Around 1.5 million people found themselves homeless and had to move to spontaneously raised campsites in and around Port-au-Prince. The crowded living conditions brought about by the displacement, the disruption of the poor water and sanitation infrastructure, and the thereby prevented adequate personal hygiene, aggravated the risk of diarrhoeal disease, as is usually the case during humanitarian disasters (regarding the spread of diarrhoea after disasters see Linscott, 2007; Waring & Brown, 2005; Watson, Gayer, & Connolly, 2007; Wisner & Adams, 2002). More precisely, cholera broke out in October 2010, spread to all 10 provinces of Haiti, causing 653,789 cholera cases and 8,066 fatalities (case report from April 14 2013; Ministère de la Santé Publique et de la Population, 2013).

Diarrhoeal disease, including cholera, is transmitted primarily via the faecal-oral route. Since hands are the main vector, the single most effective preventative measure is one of the simplest and cheapest: handwashing with soap[7] at key times (Curtis et al., 2000; Curtis et al., 2011). Consequently, to combat the aggravated risk of diarrhoeal disease during disasters, the promotion of handwashing is an essential part of nearly every emergency relief. Thus, many relief organisations responded to the Haiti earthquake with handwashing promotions, which were scaled up after the cholera outbreak. The promotions were often based on recommendations by the WASH[8] Cluster Haiti (Direction Nationale de l'Eau Potable et de l'Assainissement & United Nations Children's Fund, 2011).

Similar hygiene promotions have been used globally in various emergency situations inasmuch as the Global WASH cluster has attempted to standardise the approaches. Surprisingly, despite their wide use and standardisation efforts, the effectiveness of emergency hygiene promotions has not been adequately evaluated thus far. Instead, much of the evidence-base is drawn from hygiene interventions in the development sector (Banatvala & Zwi, 2000; Moss et al., 2006; Parkinson, 2009). However, to ensure that the handwashing promotions applied during emergencies are effective, these promotions must be studied in exactly this context. Furthermore, to our knowledge, there are only two studies testing the effectiveness of different communication channels in changing handwashing behaviour (Pinfold, 1999; Scott et al., 2008).

[7] For simplicity, in the following text “handwashing” stands for handwashing with soap.

[8] Water, Sanitation and Hygiene

This paper reports results from a cross-sectional study analysing handwashing promotions implemented by three affiliates of a relief organisation in post-earthquake Haiti. The overall objective of the study was to assess the effectiveness of handwashing promotions using different communication channels within an emergency context.

Explaining behaviour change

Effective hygiene promotions change unhealthy, unhygienic behaviour into healthy, hygienic behaviour. Behaviour change rests on changing social-cognitive factors within the individuals. Consequently, those hygiene promotions which affect the critical social-cognitive factors are most effective in changing behaviour. While various models of behaviour change suggest a multitude of potential social-cognitive factors, so far there is no agreement about which factors determine handwashing behaviour (Biran et al., 2009; Coombes & Devine, 2010; Curtis et al., 2011).

Recently, a new model of behaviour change was proposed, the Risk, Attitudes, Norms, Abilities, and Self-regulation of behavioural change model (RANAS model; Mosler, 2012), which integrates the social-cognitive factors proposed by major theories of behaviour change, such as the health belief model (Rosenstock, 1974), the protection motivation theory (Floyd, Prentice-Dunn, & Rogers, 2000), or the theory of planned behaviour (Fishbein & Ajzen, 2010), into a comprehensive model. These factors can be neatly classified into five factor blocks: risk factors, attitude factors, norm factors, ability factors, and self-regulation factors. A description of the five factor blocks can be found in Table 14. Being explicitly designed for the WASH sector in developing countries, the RANAS model constitutes a good basis to explore factors determining handwashing behaviour in an emergency context.

Table 14. Overview of the factor blocks specified in the RANAS model (Mosler, 2012)

Factor block	Description
Risk factors	Perceived susceptibility and perceived severity of contracting a disease, and factual knowledge about the possibility of being affected by a potential contamination.
Attitude factors	Instrumental beliefs about costs and benefits of the targeted behaviour, as well as affective beliefs, i.e. feelings arising when thinking about the behaviour.
Norm factors	Different normative influences: descriptive norms (behaviours typically performed by others), injunctive norms (behaviours typically approved or disapproved by others) and personal norms (personal standards about what should be done).
Ability factors	The confidence in one’s ability to organize and manage the targeted behaviour (self-efficacy).
Self-regulation factors	Help to manage conflicting goals and distracting cues when intending to implement and maintain a certain behaviour.

By applying the RANAS model, this study aimed to answer the following research questions:

(1) How was the reach of the communication channels and how were they assessed by the target population?

(2) Which social-cognitive factors influence handwashing with soap in which situations?

(3) Which communication channels impact which social-cognitive factors, and influence handwashing with soap through these factors? How strongly?

Methods

Procedure

Data was collected during five weeks over May and June 2011 by means of structured face-to-face interviews with the primary caregiver in a study household. Households were recruited from camps and neighbourhoods within which three affiliates of a well-known relief organisation had conducted hygiene promotions as part of their earthquake and/or cholera response. The study area was restricted to the metropolitan area of Port-au-Prince, and the nearby rural areas of Léogâne, Gressier, and Petit, and Grand Goâve. While these were the only areas where the affiliates worked during the earthquake response, during the cholera response they extended their work to additional areas in northern and southern Haiti. Due to logistical reasons these more distant areas in the north and south were not considered within this study. In total, data was collected from 20 sites. Within a site, every third household was chosen for interviewing using a modified random route sampling (Hoffmeyer-Zlotnik, 2003). For that, each site was subdivided into 10 areas to which the interviewers were randomly assigned to. In each area one house was randomly selected as a starting point and the assigned interviewer was instructed to try to interview every third household when walking in a specified direction. Thirty-nine households refused to take part in the interview (4.88%). Primary caregivers were interviewed as they are responsible for child care and food preparation, and thus have the highest chance of passing on diarrhoeal disease to other family members. The interviews were carried out in Créole by a team of 10 local students and scientists. The team was trained in interviewing techniques in a workshop prior to data collection, and were supervised during data collection by researchers and a field assistant. Each interview took around 45 minutes. All subjects provided informed consent.

Sample

A total sample size of 811 was achieved with the majority of study households being located in Port-au-Prince (n = 528) and a smaller sub-sample stemming from the rural areas (n = 283). Interviewees' ages ranged between 15 and 90 years (M = 34.68; SD = 12.90). In terms of gender, 713 (88%) of the respondents were female and 98 were male. While nearly half of the sample did not finish primary school (n = 395, 49%), almost a quarter did not go to school at all (n = 193, 24%). The mean income per person per day of M = 1.07 US$ was slightly below the poverty line of 1.25 US$ (Ravallion et al., 2009).

Questionnaire and measures

The questionnaire on which the interviews were based covered socio-demographic characteristics, self-reported handwashing behaviour, social-cognitive factors as attitudes and beliefs, and recalled promotional activities and attitudes towards them. A pre-test verified the applicability of the questionnaire (N = 20).

Handwashing at key times was measured by means of self-reports using 5-point Likert scales. Surveyed key times corresponded to the promoted key times, namely handwashing after defecation, after wiping a child's bottom, after other kinds of contact with stool, before eating, before preparing food, before feeding a child, and before handling water. Exploratory factor analysis proved that two different handwashing situations are distinguishable, stool-related handwashing (SRH) and food/water-related handwashing (FRH[9]). While the former subsumes handwashing after defecation, wiping a child's bottom and other kinds of contact with stool, the latter incorporates handwashing before eating, preparing food, feeding a child, and handling drinking water. Two mean scores were computed to represent the two factors (Cronbach's α = .76 and α = .81, respectively). The promotions' effectiveness was tested separately for SRH and FRH.

Social-cognitive factors The factors described in Table 15 were measured according to suggestions in the RANAS approach (Mosler, 2012). For each determinant, one or several items were included into the questionnaire. Sample items, means and standard deviations are displayed in Table 15. If several items were used, these were in most cases combined to summary variables to facilitate the analyses (see Table 15 for item numbers and Cronbach's alpha). Furthermore, 9-point Likert scales ranging from -4 to +4 were used to measure bipolar

[9] For simplicity, in the following text FRH stands for food- and water-related handwashing.

variables and 5-point Likert scales ranging from 0 to 4 were used to measure unipolar variables.

Promotional channels Experience of promotional channels was surveyed by self-reports using a dichotomous format, experienced versus not experienced (see Table 16 for an overview). In addition, attitudes towards experienced promotional activities were measured by items capturing liking, convincingness, and trustworthiness.

Data analysis procedure

First, promotional activities were examined regarding their evaluation using one-way ANOVA and Tukey post-hoc comparisons. Regression of handwashing on social-cognitive factors was inspected to select factors relevant in explaining handwashing. Only those factors with significant regression weights within multiple linear regression analyses were included in subsequent mediation analyses. Social-cognitive factors were entered into the regression model by forced-entry, which means that all factors were entered simultaneously. Within mediation analyses the direct and indirect effects of promotional activities on handwashing behaviour were tested. Indirect effects are the influences of a promotional activity on behaviour via social-cognitive factors. An indirect effect is obtained by multiplying the influence a promotional activity has on a single social-cognitive factor with the influence that this single social-cognitive factor has on handwashing. Mediation analyses were realised applying the indirect method by Preacher and Hayes (2008).

Table 15. Overview of the social-cognitive factors: Items, means, standard deviations and Cronbach's alphas for scales

Factor groups	Social-cognitive factors	Item examples	Range	*M*	*SD*	α
Risk factors	Perceived vulnerability (1 item)	How high or low do you feel are the chances that you or someone in your family gets cholera?	-4–4	-2.08	1.91	–
	Perceived cholera severity (3 items)	Imagine that you contracted cholera, how severe would be the impact on your life in general?	0–4	2.62	0.90	.85
	Health knowledge (4 items)	What are the effects of cholera on your body?	0–4	1.12	0.37	.64
Attitude factors	*Instrumental beliefs*					
	Efforts (4 items)	Do you think that washing hands with soap is time-consuming?	0–4	0.76	0.66	n.a.
	Response efficacy (1 item)	How certain are you that washing hands with soap after defecation and before handling food prevents you and your family from getting diarrhoea or cholera?	0–4	3.17	0.70	–
	Attractiveness (1 item)	I feel more attractive when I have washed my hands with perfumed soap.	-4–4	1.68	2.42	–
	Nurture: Teaching and caring (3 items)	It is important to teach the children to wash their hands with soap.	-4–4	2.93	0.75	n.a.
	Return (1 item)	Considering all the benefits and efforts related to washing hands with soap, how much do you think is it worthwhile for you to wash hands with soap?	-4–4	2.47	1.57	–
	Affective beliefs					
	Liking and pleasantness (2 items)	How much do you like or dislike washing hands with soap?	-4–4	2.95	0.73	.55
	Soap attributes: Smell (1 item)	How much do you like or dislike the smell of the soap?	-4–4	2.55	1.26	–
	Disgust (3 items) - stool	I feel dirty and smelly if I don't wash my hands with soap after visiting the toilet.	-4–4	2.59	1.16	n.a.
	Disgust (2 items) – food	I wash my hands with soap before handling food because it would be disgusting to get dirt into the food and then eat it.	-4–4	2.51	1.26	n.a.
	Attitude towards cholera patients (1 item)	What do you think of people who have cholera?	-4–4	-0.71	1.97	–

(continued)

Table 15 (continued). Overview of the social-cognitive factors: Items, means, standard deviations and Cronbach's alphas for scales

Factor groups	Social-cognitive factors	Item examples	Range	*M*	*SD*	α
Norm factors	Descriptive norm family (1 item) - stool	How many people of your relatives wash hands with soap after contact with stool?	0–4	3.62	0.76	–
	Descriptive norm family (1 item) – food	How many people of your relatives wash hands with soap before handling food?	0–4	3.59	0.82	–
	Descriptive norm community (1 item) - stool	How many people of your community wash hands with soap after contact with stool?	0–4	2.21	1.21	–
	Descriptive norm community (1 item) - food	How many people of your community wash hands with soap before handling food?	0–4	2.16	1.18	–
	Injunctive norm (2 items) - stool	Most of the people who are important to me think I should wash my hands with soap after contact with stool.	-4–4	2.01	1.14	.87
	Injunctive norm (2 items) - food	Most of the people who are important to me think I should wash my hands with soap before handling food.	-4–4	1.99	1.14	.89
	Personal norm (2 items) - stool	I feel a strong personal obligation to wash hands with soap after contact with stool.	-4–4	2.75	1.27	.72
	Personal norm (2 items) - food	I feel a strong personal obligation to wash hands with soap before handling food.	-4–4	2.70	1.35	.79
	Compliance mobilizers (1 item)	I wash my hands with soap because that is what the hygiene mobilizers told us.	-4–4	2.13	1.98	–
Ability factors	Motivational self-efficacy (2 items) - stool	How difficult or easy is it to always wash hands with soap after contact with stool?	-4–4	3.09	0.67	.65
	Motivational self-efficacy (2 items) - food	How difficult or easy is it to always wash hands with soap after contact with stool?	-4–4	3.05	0.74	.69
	Volitional self-efficacy (1 item)	Imagine you have stopped washing hands with soap for several days. How confident are you to start washing hands with soap again?	0–4	3.11	0.51	–

(continued)

Table 15 (continued). Overview of the social-cognitive factors: Items, means, standard deviations and Cronbach's alphas for scales

Factor groups	Social-cognitive factors	Item examples	Range	*M*	*SD*	α
	Impediments					
	General impediments (1 item)	How often does it happen that you want to wash hands with soap but are hindered in doing so?	0–4	0.88	0.96	–
	HW-station out of order (2 items)	How often does it happen that the hand washing station is damaged?	0–4	0.71	0.84	.65
	No water or no soap (2 items)	How often does it happen that there is no soap available at the hand washing station?	0–4	1.54	0.92	.67
Self-regulation factors	Forgetting (1 item) – stool	How often does it happen that you forget to wash hands with soap after contact with stool?	0–4	0.70	1.02	–
	Forgetting (1 item) – food	How often does it happen that you forget to wash hands with soap before handling food?	0–4	0.99	1.03	–
	Coping planning: Detailed plan (2 items) - stool	Have you made a detailed plan regarding how to avoid forgetting to wash hands with soap after contact with stool?	0–4	2.51	0.85	.80
	Coping planning: Detailed plan (2 items) - food	Have you made a detailed plan regarding how to avoid forgetting to wash hands with soap before handling food?	0–4	2.46	0.87	.78

Note. *N* = 745. N.a. = not applicable: items are that divers that a joint variance is not expected and thus Cronbach's alphas are not applicable. Still, the items were combined to scales due to theoretical reasons.

Results

Reach and respondents' evaluation of the communication channels

Sixteen different communication channels promoted handwashing based on recommendations by the WASH Cluster Haiti (Direction Nationale de l'Eau Potable et de l'Assainissement & United Nations Children's Fund, 2011; Hygiene Promotion sub-cluster Haiti, 2010; see Table 15 for an overview of the communication channels). While the WASH Cluster Haiti has recognised that knowledge alone is not sufficient to change behaviour, the recommended hygiene promotions were still built mainly on knowledge formation by explaining the chain of contamination, handwashing key times, and/or good and bad behaviour (Direction Nationale de l'Eau Potable et de l'Assainissement & United Nations Children's Fund, 2011). Top-down information channels were used, as were interactive, bottom-up activities thatfoster mutual learning and self-help. Exemplary promotional messages were "sante'w depann de men'w ki pwòp (health depends on clean hands)" or "lave men pwoteje lavi (wash hands, protect life)".

Table 16 displays the reach of the communication channels within the sample. The channel with the highest reach was the radio spot with a reach of 92%. Stickers, posters and paintings with a reach of 76% and information spread by megaphone with a reach of 73% were the activities with second and third highest reach. At the other side of the scale were quizzes with a reach of only 16%, followed by radio program (28%), cinema shows (31%), and theatres (34%).

Table 16. Overview of the promotional activities and percentage of people who experienced the activity

Promotional activity	Description	% exp.
Radio spot	First step intervention tool to spread information as quickly as possible to as many persons as possible. Created, coordinated and managed by MSPP in collaboration with the INGO community. Applied primarily after the cholera outbreak. Popular radio channels were identified and spots about hand washing and cholera were aired. Main goal: information/education.	92%
Radio program	First step intervention tool to spread information as quickly as possible to as many persons as possible. Interactive program with an expert from a relief organisation which answered listeners' questions. Main goal: information/education.	28%
Information spread by megaphone	First step intervention tool to spread information as quickly as possible to as many persons as possible. Sometimes only top down information, sometimes interactive with questions and answers. Main goal: information/education and mobilization.	73%
Group discussion / Community reunion	Group activity with 10-12 persons of differing target (adults, children, women, men). Important tools: picture cards used for "three-pile-sorting", chain of contamination and analysis of problem; questions and answers; brain storming etc. Goals: Discuss (remaining) questions, deepen understanding, and explore beliefs.	56%

(continued)

Table 16 (continued). Overview of the promotional activities and percentage of people who experienced the activity

Promotional activity	Description	% exp.
Hygiene training	2-3 day training initially with head of household, later with other target groups. Includes several activities as group discussions, role plays, educative films etc. and focuses on a specific topic. The third day is dedicated to practical demonstration of how to use the items in a hygiene kit. Attendance of the training is rewarded with a coupon which entitles to receive a hygiene kit.	32%
Home visit / Face-to-face promotion	Second step intervention tool after mass promotion, group discussion, training sessions etc. Primary recipient is head of household. Tool: picture cards used for "three-pile-sorting", chain of contamination and analysis of problem. Main goal: clarify remaining questions, education. Sometimes combined with distribution of soap, aquatabs, flyers etc.	67%
Material distribution with demonstration	Mass distributions where the correct use of the material is explained, demonstrated and exercised. Main goal: distribute material and ensure correct utilization.	51%
Information from a neighbour / friend	Side benefit of any promotion tool where a promotion recipient shares the gained information with its neighbours/friends.	61%
Focus group	Reunion to discuss problems within the community, to get feedback to the promotions, to assess knowledge, behaviour and attitude. Tool: questionnaires.	40%
Cinema show	Screening of educative films about health issues, sometimes in connection with a meeting. Main goal: information/education.	34%
Theatre	Plays with singing and dancing about hand washing, hygiene, chain of contamination etc. Played by professionals (OQ) or lay persons (mobilizers, camp inhabitants, adults and children; IO and OGB). In interaction with the audience which is asked questions and has to demonstrate behaviour. Sometimes only at special events like global handwashing day, sometimes without special occasion. Goal: Demonstrate good and bad behaviour.	31%
Special hygiene day	Special days that focus on a specific topic (hand washing, water consumption etc.) and apply a range of promotion tools as theatre, songs, quiz, demonstration sessions etc.	42%
Quiz	Quiz about good and bad behaviour regarding hygiene, hand washing, cholera or diarrhoea. Sometimes with soap as a prize. Conducted during meetings and special events.	16%
Stickers/Posters/ Paintings	Stickers, posters and paintings that inform about correct behaviour and health issues and serve as reminders. Hang up/painted at key places as latrines, hand washing station, water source etc.	76%
Community club	Meetings of a specific target group (e.g. mothers) on a regular basis to discuss and solve problems and foster self-help.	40%
Hygiene songs	Songs about different health topics sang in the camps by megaphone, at meetings, at events, aired in the radio. Some provided by relief organisations, others created by the communities. Goal: Spread information about good behaviour and as a reminder.	50%

Respondents were asked to evaluate the experienced communication channels regarding liking, convincingness, and trustworthiness.[10] While all the communication channels were positively evaluated there are some differences in the magnitude. A one-way ANOVA revealed that liking differed significantly across the communication channels, $F(13, 1699) = 7.19$, $p \leq .000$.[11] Table 17 shows that respondents favoured hygiene trainings, radio spots, and cinema shows most. Least favoured were focus groups, and stickers, posters, and paintings. Tukey post-hoc comparisons indicated that information from neighbour or friend ($M = 3.07$, 95% CI [3.02, 3.12]), along with the more favoured promotional activities, was significantly more liked than stickers, posters, and paintings ($M = 2.94$, 95% CI [2.89, 3.00]), or focus groups ($M = 2.91$, 95% CI [2.84, 2.98]), $p < .05$. Further, hygiene days ($M = 2.99$, 95% CI [2.94, 3.05]) were significantly less liked than radio spots ($M = 3.14$, 95% CI [3.10, 3.18]) and hygiene trainings ($M = 3.15$, 95% CI [3.09, 3.21]), $p < .05$.

Table 17. Respondents' evaluation of the promotional activities

Promotional activity	Liking		Convincingness		Trustworthiness	
	M	*SD*	*M*	*SD*	*M*	*SD*
Radio spot	3.14 [a, c]	0.51	3.08 [a, c]	0.63	3.01 [a, c]	0.64
Radio program	3.10 [a]	0.66	3.08 [a]	0.73	3.00 [a]	0.79
Megaphone	3.01	0.52	2.93	0.66	2.86 [a]	0.65
Group discussion	3.03	0.59	2.94	0.72	2.88 [a]	0.69
Hygiene training	3.15 [a, c]	0.50	3.08 [a]	0.58	3.00 [a]	0.50
Home visit	3.11 [a]	0.47	3.05 [a]	0.55	3.01 [a]	0.49
Material distribution	3.07 [a]	0.45	3.06 [a]	0.46	2.99 [a]	0.49
Info neighbour / friend	3.07 [a]	0.52	2.99 [a]	0.57	2.93 [a]	0.58
Focus group	2.91 [b]	0.64	2.80 [b]	0.75	2.69 [b]	0.81
Cinema show	3.13 [a]	0.52	3.03 [a]	0.56	3.01 [a, c]	0.49
Theatre	3.12 [a]	0.37	3.07 [a]	0.49	3.03 [a, c]	0.35
Special hygiene day	2.99 [d]	0.49	2.93 [d]	0.62	2.83 [d]	0.65
Quiz	3.05	0.47	3.02 [a]	0.52	2.96 [a]	0.54
Stickers, posters, paintings	2.94 [b]	0.67	2.83 [b]	0.80	2.72 [b]	0.87

Note. N = 129-745. Within columns means marked with [a] differ at $p < .05$ in the Tukey honestly significant difference comparison from means marked with [b]. Within columns means marked with [c] differ at $p < .05$ in the Tukey honestly significant difference comparison from means marked with [d].

[10] Hygiene songs were not evaluated regarding liking, convincingness, and trustworthiness.
[11] For all one-way ANOVA results, Welch's *F*-ratios are reported.

Convincingness also differed significantly across the communication channels, $F(13, 1701) = 7.87$, $p \leq .000$. Radio spots were rated as the most convincing communication channel, followed by hygiene trainings and radio programs (see Table 17). Least convincing were focus groups, followed by stickers, posters, and paintings, and hygiene days. Tukey post-hoc comparisons showed that information from neighbours or friends ($M = 2.99$, 95% CI [2.94, 3.04]), along with all higher rated communication channels, was significantly more convincing than stickers, posters, and paintings ($M = 2.83$, 95% CI [2.76, 2.89]), or focus groups ($M = 2.80$, 95% CI [2.72, 2.88]), $p < .05$. Further, hygiene days ($M = 2.93$ 95% CI [2.86, 2.99]) were significantly less convincing than radio spots ($M = 3.08$, 95% CI [3.04, 3.13]), $p < .05$.

Regarding trustworthiness, one-way ANOVA again revealed significant differences across the communication channels, $F(13, 1965) = 10.50$, $p \leq .000$. Theatre was rated as the most trustworthy promotional activity, followed by cinema show and radio spot (see Table 17). Least trustworthy were focus groups, followed by stickers, posters, and paintings, and hygiene days. Tukey post-hoc comparisons depicted that information spread by megaphone ($M = 2.86$, 95% CI [2.81, 2.91]) along with all higher rated promotional activities was significantly more trustworthy than stickers, posters, and paintings ($M = 2.72$, 95% CI [2.65, 2.79]), or focus groups ($M = 2.69$, 95% CI [2.60, 2.78]), $p < .05$. Further, hygiene days ($M = 2.83$, 95% CI [2.76, 2.90]) were significantly less trustworthy than radio spots ($M = 3.01$, 95% CI [2.96, 3.05]), cinema shows ($M = 3.01$, 95% CI [2.96, 3.07]), and theatres ($M = 3.03$, 95% CI [2.98, 3.07]), $p < .05$.

All in all, focus groups, hygiene days, and stickers, posters, and paintings were rated as less likable, less convincing, and less trustworthy than other promotional activities.

Influencing stool-related handwashing

On average, respondents washed their hands frequently after contact with stool with mean levels of $M = 3.57$ ($SD = 0.56$). Forced-entry multiple linear regression analysis revealed that seven social-cognitive factors were associated with increased handwashing (Appendix II, Table A-3): return, response efficacy, pleasantness of perfume, disgust, descriptive norm of the community, motivational self-efficacy, and coping planning. In addition, two social-cognitive factors were associated with decreased handwashing: general impediments and, counterintuitively, health knowledge. These nine social-cognitive factors were selected to examine indirect and direct effects of promotional activities on handwashing by means of mediation analysis.

For mediation analysis the indirect method by Preacher and Hayes (2008) was used. Table 18 summarises the association of the communication channels with the social-cognitive factors, and their total indirect, direct, and total effects on SRH. Appendix II, Table A-4 presents the results regarding the relationship between the selected social-cognitive factors and SRH. Together, the social-cognitive factors and the communication channels explained 45% of the variance in SRH. This corresponds to a population effect size of $f^2 = .82$, which is a large effect (Cohen, 1992).

When looking at the total effects, four communication channels were significantly associated with increased SRH: radio spots, radio programs, material distributions, and information from neighbours or friends. Against expectations, three communication channels were associated with decreased SRH: focus groups; stickers, posters and paintings; and hygiene songs. While most of the remaining nine communication channels (information spread by megaphone; group discussion; hygiene training; home visit; cinema show; theatre; special hygiene day; quiz; and community club) were significantly related with some of the social-cognitive factors, none had a significant total effect on SRH. Further, none of the 16 communication channels was significantly associated with the social-cognitive factor "return". Additional promotional activities are needed to trigger this social-cognitive factor (see discussion).

Table 18. Mediation results: Effects of promotional activities on social-cognitive factors explaining SRH, and total indirect, direct and total effects of promotional activities on SRH

	Social-cognitive factors											
	Risk	Attitude				Norm	Ability		Self-regul.			
Promotional activity	Know-ledge	Smell of soap	Resp. effic.	Return	Disgust	Descr. norm	Motivational SE	Impediments	Coping planning	Total indirect effects [95% CI]	Direct effects	Total effects
Radio spot	-0.01	0.17***	0.04	0.09	0.08	-0.02	0.11***	-0.08*	0.09**	0.06 [0.02, 0.09]	0.00	0.06**
Radio program	0.01	0.01	0.04*	0.01	0.02	-0.02	0.01	0.02	-0.02	-0.00 [-0.01, 0.01]	0.04***	0.04***
Megaphone	0.02*	0.00	0.01	0.02	-0.05	-0.01	-0.01	0.03	-0.00	-0.01 [-0.02, 0.01]	-0.00	-0.01
Group discussion	-0.01	0.01	0.05**	0.04	0.08**	-0.06*	0.02	-0.01	0.03	0.02 [-0.00, 0.03]	0.01	0.02
Hygiene training	-0.01	0.04	-0.02	-0.02	0.02	0.04	0.02	-0.02	0.03	0.01 [-0.00, 0.03]	-0.01	-0.00
Home visit	0.01	-0.10**	-0.02	-0.03	-0.03	0.02	-0.02	0.03	-0.01	-0.02 [-0.03, 0.00]	-0.00	-0.02
Material distrib.	-0.00	0.10***	0.04**	-0.00	0.02	0.06*	0.05***	-0.08***	0.08***	0.04 [0.02, 0.06]	0.00	0.04***
Info neighb./friend	-0.02**	0.04	-0.02	0.03	0.06*	0.10***	0.07***	-0.06**	0.05**	0.04 [0.02, 0.05]	-0.01	0.03*
Focus group	0.03***	-0.08*	-0.00	-0.02	-0.07*	0.03	-0.06***	0.04	-0.06**	-0.03 [-0.05, -0.02]	-0.00	-0.04**
Cinema show	-0.02**	0.03	0.01	-0.00	0.00	0.02	0.04*	-0.01	0.03	0.02 [0.00, 0.03]	-0.02	0.00
Theatre	-0.01	0.04	-0.00	0.03	0.07*	0.04	0.01	-0.06**	0.05*	0.02 [0.01, 0.04]	0.00	0.03
SHD	0.02*	-0.00	-0.02	-0.06	-0.04	-0.04	-0.04**	0.06**	-0.06**	-0.03 [-0.05, -0.01]	0.02*	-0.01
Quiz	0.01	0.01	-0.01	-0.07	-0.00	0.01	-0.01	-0.00	-0.01	-0.01-0.03, 0.01]	0.02	0.01
SPP	0.02*	-0.08*	0.01	-0.05	-0.00	-0.08**	-0.02	0.06*	-0.02	-0.02 [-0.04, -0.01]	-0.02	-0.04*
Community club	-0.01	0.09**	-0.00	0.00	-0.01	0.07*	0.04*	-0.05*	0.05*	0.03 [0.01, 0.05]	-0.01	0.02
Hygiene song	0.05***	-0.09**	0.00	-0.02	-0.09***	0.01	-0.09***	0.07***	-0.08***	-0.05 [-0.06, 0.03]	0.01	-0.04***

Note. N = 653. Self-regul. = Self-regulation. Resp. effic. = Response efficacy. Descr. norm = Descriptive norm. Motivational SE = Motivational self-efficacy. CI = Confidence interval. Material distrib. = Material distribution. Infor neighb./friend = Information neighbour/friend. SHD = Special hygiene days. SPP = Stickers, posters, paintings. Displayed are unstandardized coefficients. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Influencing food-related handwashing

For FRH, the mean level of handwashing was again rather high with an average of M = 3.04 (SD = 0.82). Eight social-cognitive factors were significantly associated with increased FRH (see Appendix II, Table A-5): perceived severity, pleasantness of perfume, feeling attractive, family's descriptive norm, injunctive norm, motivational self-efficacy, coping planning, and, counterintuitively, impediment due to impaired handwashing stations. In addition, four social-cognitive factors were associated with decreased handwashing: attitudes towards cholera patients, general impediment, impediment due to lack of soap or water and forgetting. While these 12 social-cognitive factors were initially selected for further analyses, three of them lacked significance within mediation analyses: attitudes towards cholera patients, impediment due to impaired handwashing stations and impediment due to lack of soap or water. Consequently, they were excluded from further analyses.

In Table 19, the association of the communication channels with social-cognitive factors and their total indirect, direct, and total effects on FRH are presented. Results regarding the relationship between the selected social-cognitive factors and FRH are shown in Appendix II, Table A-6. The communication channels together with the social-cognitive factors accounted for 61% of the variance in FRH. The according population effect size is f^2 = 1.56. This is a large effect (Cohen, 1992).

Regarding total effects, mediation analysis revealed five communication channels which were significantly associated with increased food related handwashing: radio spots, material distributions, information from neighbours or friends, theatre, and community clubs. Counterintuitively, five significant associations with decreased FRH were revealed: home visits; focus groups; special hygiene days; stickers, posters and paintings; and hygiene songs. Of the remaining six communication channels (radio program; information spread by megaphone; group discussion; hygiene training; cinema show; and quiz), most were significantly related with at least one of the social-cognitive factors. However, none of them had a significant total effect on FRH.

Table 19. Mediation results: Effects of promotional activities on social-cognitive factors explaining FRH, and total indirect, direct and total effects of promotional activities on FRH

	Social-cognitive factors											
	Risk	Attitude		Norm		Ability		Self-regulation				
Promotional activity	Seve-rity	Smell of soap	Attrac-tiveness	Descr. norm	Inj. norm	Motivational SE	Impediments	For-getting	Coping planning	Total indirect effects [95% CI]	Direct effects	Total effects
Radio spot	0.01	0.18***	0.10	0.08**	0.12**	0.08***	-0.04	-0.07	0.05	0.07 [0.02, 0.12]	-0.00	0.07**
Radio program	0.02	0.01	0.07	-0.04*	0.04	0.01	0.01	0.04	-0.02	-0.01 [-0.03, 0.02]	0.04**	0.03
Megaphone	0.00	0.02	-0.05	0.02	0.01	-0.03*	0.02	0.02	-0.01	-0.01 [-0.03, 0.01]	0.00	-0.01
Group discussion	0.03	-0.00	-0.06	-0.02	0.01	0.04*	-0.00	0.00	0.02	0.01 [-0.01, 0.04]	0.02	0.03
Hygiene training	0.01	0.04	0.06	0.03	0.03	-0.00	-0.01	-0.03	0.02	0.02 [-0.01, 0.05]	0.01	0.03
Home visit	-0.03	-0.10**	-0.07	-0.04*	-0.04	-0.02	0.03	0.02	-0.02	-0.03 [-0.06, -0.00]	-0.02	-0.05**
Material distrib.	0.04*	0.10***	0.18***	0.06***	0.11***	0.08***	-0.08***	-0.04	0.08***	0.07 [0.05, 0.10]	0.00	0.08***
Info neighb./friend	-0.02	0.05	0.18***	0.06***	0.07**	0.06***	-0.05**	-0.06**	0.05**	0.05 [0.03, 0.08]	0.00	0.06***
Focus group	0.05*	-0.07*	-0.17**	-0.03	-0.10***	-0.09***	0.03	0.03	-0.05*	-0.05 [-0.08, -0.02]	-0.02	-0.07***
Cinema show	0.02	0.02	0.05	0.07***	0.02	0.04*	-0.00	0.00	0.04*	0.03 [0.00, 0.05]	-0.03*	0.00
Theatre	-0.04*	0.02	0.12*	0.04	0.10***	0.03*	-0.06**	-0.09***	0.03	0.05 [0.02, 0.07]	0.02	0.06***
SHD	-0.03	-0.01	-0.15**	-0.04*	0.12***	-0.08***	0.07**	0.05*	-0.06**	-0.07 [-0.09, -0.04]	-0.00	-0.07***
Quiz	-0.06*	0.01	-0.01	0.01	0.04	0.01	-0.02	-0.01	-0.00	0.00 [-0.03, 0.03]	0.02	0.02
SPP	-0.01	-0.05	-0.10	-0.04*	-0.03	-0.01	0.06*	0.04	-0.01	-0.03 [-0.06, -0.00]	-0.01	-0.04*
Community club	-0.01	0.10**	0.29***	0.06**	0.07**	0.06***	-0.05*	-0.07**	0.06**	0.06 [0.04, 0.09]	0.00	0.07***
Hygiene song	0.02	-0.09***	-0.19***	-0.07***	-0.14***	-0.08***	0.06**	0.04	-0.09***	-0.08 [-0.10, -0.05]	0.01	-0.06***

Note. N = 653. Descr. norm = Descriptive norm. Inj. norm = Injunctive norm. Motivational SE = Motivational self-efficacy. CI = Confidence interval. Material distrib. = Material distribution. Infor neighb./friend = Information neighbour/friend. SHD = Special hygiene days. SPP = Stickers, posters, paintings. Displayed are unstandardized coefficients. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Discussion

Summary and interpretation of the results

The present study is one of the first to investigate handwashing promotions in emergency relief. Herewith, a first step is taken towards establishing a much-needed evidence-base for emergency hygiene promotions. Due to the lack of previous research, however, the study's results could not be compared with existing findings in this context. Instead, findings from other contexts served as reference for comparison.

The study aimed to specify which promotional activities are associated with which social-cognitive factors, and, accordingly, how strong their association is with SRH and FRH in an emergency situation. In order to make these investigations, the first step was to determine the social-cognitive factors which explain SRH and FRH in an emergency context. Attitude factors appeared to be essential, particularly in explaining SRH; while pleasantness of perfume was associated with SRH and FRH, and attractiveness explained FRH, response efficacy, return, and disgust were relevant regarding SRH. In terms of norms, the descriptive norm community was relevant in explaining SRH, while descriptive norm family and injunctive norm were important with regards to FRH. With motivational self-efficacy and impediments being relevant regarding both types of handwashing, ability factors proved to be important too. Of the self-regulation factors, only coping planning was revealed to explain SRH and FRH. Little support was found for the importance of risk factors: perceived cholera severity was relevant only regarding FRH. Health knowledge explained only SRH. Moreover, the latter association was even negative. While in previous research knowledge was never negatively associated with handwashing, results were mixed with some studies revealing positive associations and some indicating no association (e.g. Biran et al., 2009; Devine et al., 2012).

In terms of explained variance, the social-cognitive factors together with the promotional activities were somewhat more effective in explaining FRH. Still, with large effect sizes for SRH and FRH, the amount of explained variance was satisfying regarding both behaviour types. All in all, the factors specified in the RANAS model seem to be adequate to explain handwashing behaviour in an emergency context.

In terms of promotional activities, for both types of handwashing the most effective promotions were material distributions with demonstrations and radio spots. To our knowledge, thus far material distributions with demonstrations were not evaluated with regard to handwashing. However, a meta-analysis on HIV prevention interventions showed that condom provisions and behavioural skills trainings are very effective in changing behaviour (Albarracin et al., 2005). In addition to the positive effect of radio spots on both types of behaviour, radio programs also had significant positive total effect on SRH. These results are in line with research in Kenya where radio shows (along with other mass media approaches) were more effective than community events in promoting handwashing (Scott et al., 2008). In contrast, results from other prevention interventions, such as HIV/AIDS or smoking, revealed that mass media was less effective than interpersonal communication (Agha & Rossem, 2002; Korhonen, Uutela, Korhonen, & Puska, 1998).

In terms of FRH, community clubs and theatres were relevant in addition to the aforementioned activities. Similarly to the latter result, dramas were effective in promoting sexual responsibility among young people in Zimbabwe (Kim, Kols, Nyakauru, Marangwanda, & Chibatamoto, 2001), and proved successful in delivering HIV/AIDS information in Uganda (K. J. Mitchell, Nakamanya, Kamali, & Whitworth, 2001). Spontaneous, unplanned promotions by friends and neighbours were also influential regarding both handwashing behaviours. Similar results were found regarding various health prevention such as reproductive health (Valente & Saba, 1998) or smoking (Korhonen et al., 1998). These person-to-person channels could be deliberately utilised by motivating beneficiaries to talk with their peers on the subject of handwashing. Although the above mentioned promotional activities seem to be quite successful, their impact could be improved inasmuch as they could target critical social-cognitive factors not yet adequately addressed. In the case of SRH, none of the promotional activities tackle return (the belief that it is worthwhile to wash hands), and only a few target response efficacy (the belief that handwashing prevents diarrhoea) and descriptive norm community (the belief that community members do wash their hands). In the case of FRH, only a few of the promotional activities address the perceived severity of cholera contagion and forgetting. The promotional activities should be modified in order to target these factors.

While all the applied promotional activities aim to foster handwashing behaviour in an emergency situation, the analyses revealed some of the activities were significantly negatively related with handwashing at key times. Three promotional activities were related with decreased SRH and FRH: focus groups, hygiene songs, and stickers, posters, and paintings. In terms of hygiene songs, the result contrasted with previous findings in the field of handwashing (Scott et al., 2008) and nutrition (Hussain, Kvåle, & Aarø, 1997). In terms of stickers and posters, Pinfold (1999) found mixed results in Thailand; while stickers and posters were significantly positively related with campaign knowledge, they were in tendency negatively related with handwashing behaviour. Two additional promotional activities were negatively associated with FRH: home visits and hygiene days. Again, this is in contrast with previous research showing the positive effects of home visits (Agha & Rossem, 2002; Hussain et al., 1997), and special events such as hygiene days (Kim et al., 2001).

While the five promotional activities with negative associations are rather different in form and content, three of them have one commonality: respondents evaluated focus groups, hygiene days, and stickers, posters, and paintings significantly less positively than the other promotional activities. Focus groups were primarily held to evaluate the relief organisations' work, and to discuss problems within the community. As every promotional program has its qualities and flaws, evaluation reveals not only positive but as well negative aspects of a program. The discussion of problems in the community clearly focuses on arisen difficulties, and, hence, negative aspects of a program as well. Respondents who participated in a focus group might have been primarily confronted with negative aspects of a promotional program, and hence doubted its convincingness and trustworthiness. Further, it might be that people were adversely recruited to participate in a focus group, that the expectations of people attending a focus group were not met, or that the focus group was perceived as effortful (e.g. bad timing, time consuming, not entertaining). While the affiliates organised several hygiene days, the biggest event was the global handwashing day on October 15, 2010. Although this event in itself might have been a success, it was retrospectively overshadowed by the fact that cholera broke out just days following the event. Ironically, rumours circulated that the global handwashing day caused the cholera outbreak, despite the fact this day celebrated one of the most crucial preventers of cholera. This negative coincidence might have lowered the trustworthiness and convincingness of the promotional activity.

While a decrease in liking, convincingness, and trustworthiness may explain why focus groups, hygiene days, and stickers, posters, and paintings are negatively related with handwashing, this is not true for home visits. Although home visits were negatively associated with FRH as well, they were rated rather favourably regarding liking, convincingness, and trustworthiness. Hygiene songs were not evaluated within the interviews. Thus, it is not clear if hygiene songs were rated favourably or unfavourably.

Implications for practitioners

To change behaviour successfully, promotional activities must address the factors which influence behaviour. The study revealed that attitude, norm, ability, and self-regulation factors are more important in explaining handwashing behaviour in an emergency situation than risk factors. Current promotional approaches in the WASH sector, however, still focus primarily on risk factors (Direction Nationale de l'Eau Potable et de l'Assainissement & United Nations Children's Fund, 2011). Consequently, these should be additionally adapted to address critical factors, such as forgetting or disgust. Special attention should be given to the factor return which was not associated with any of the implemented handwashing promotions in Haiti. Hence, future promotional activities should trigger the belief that it is worthwhile to wash hands, that is, that handwashing is instrumental for attractiveness and reputation, and to avoid evoking disgust.

Of the applied handwashing promotions, material distributions and radio spots seem to be most promising, and can be recommended for use during emergencies. In addition, both promotion activities can reach a large group of beneficiaries within a short period of time, what is essential especially in the beginning of an emergency relief. Still, additional evaluation studies are required to further the evidence-base in an emergency setting. In contrast, focus groups, stickers, posters, and paintings, hygiene songs, hygiene days, and home visits were negatively related with handwashing. Consequently, additional research in emergency contexts should study their effects thoroughly to rule out behaviour-impairing effects.

Strength, limitations, and future studies

By revealing negative associations of several promotional activities with behaviour, the present study highlights the urgent need to carefully evaluate emergency hygiene promotions. However, studies in an emergency context are especially prone to the following limitations.

During emergencies, baseline data collections are not feasible due to time pressure. Further, use of control groups is not appropriate due to ethical concerns. As a consequence, the present study is based on cross-sectional, correlational data, and reveals associations between promotional activities, social-cognitive factors, and behaviour. However, no conclusions regarding causality are possible.

Relief organisations applied several promotional activities without applying different intervention groups. Consequently, beneficiaries experienced various combinations of activities. It is possible that the combination of some activities were especially effective or hindering, or that a promotional activity on its own would have been effective but not in combination with the others. Hence, interaction effects should be taken into account. However, out of the sheer number of applied promotional activities, it was not feasible to test for interaction effects exhaustively.

Further, several scholars emphasised the problem of inflated self-reports in terms of socially desirable behaviour, and argue that handwashing behaviour should be observed instead (Biran et al., 2008; Curtis et al., 1993; Halder et al., 2010; Manun'Ebo et al., 1997). Still, due to feasibility issues in the present study data regarding handwashing had to be collected by means of self-report. However, since the study focused on relations and did not aim to draw conclusions about frequencies in the population, self-reports should not cause a problem. Overestimations do not affect relations, and their relative magnitude should not be biased. Still, a validation of the results by means of observational data would be preferable.

Targets of the study were primary caregivers. As a consequence, female adults are highly over represented in the sample. Hence, the research findings primarily apply to women. It might be that different conclusions would be drawn for male beneficiaries or children. This should be tested in subsequent analysis.

Focus groups, stickers, posters, and paintings, hygiene songs, hygiene days, and home visits were negatively related with handwashing. While the result is partly substantiated by the fact that these promotional activities tended to be evaluated as less likable, less convincing, and less trustworthy, the negative relations are not fully explained so far. As a consequence, subsequent research should analyse these negative relations in-depth to further reveal the reason and mechanism of action.

Conclusions

The present study demonstrates that hygiene promotions in emergency relief should not be designed and implemented according to standard approaches based solely on the personal experience of relief workers (Aboud & Singla, 2012). Instead, theories of behaviour change should be taken into account, and promotions should be designed based on evidence in order to specifically target those social-cognitive factors critical in eliciting the behaviour in question. Further, in-depth evaluations of promotional activities are inevitable to maximise their effectiveness and eliminate unwanted effects, such as behaviour impairment. This is especially true for emergency interventions for which the evidence-base is still limited but the number of lives at stake is high.

Additional information

Appendix II contains results from linear regression and mediation analyses for social-cognitive factors.

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Part Four

Theory- and evidence-based population-tailored handwashing interventions

Chapter I – Changing handwashing behaviour in southern Ethiopia: A longitudinal study on infrastructural and commitment interventions

Nadja Contzen, Iara Meili, & Hans-Joachim Mosler

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Abstract

Improved hand hygiene efficiently prevents the major killers of children under the age of five years in Ethiopia and globally, namely diarrheal and respiratory diseases. Effective handwashing interventions are thus in great demand. Evidence- and theory-based interventions, especially when matched to the target population's needs, are expected to perform better than common practice. To test this hypothesis, we selected two interventions drawing on a baseline questionnaire-study that applied the RANAS (Risk, Attitudes, Norms, Abilities, Self-regulation) approach and focused on the primary caregivers of households in four rural, water-scarce kebeles (smallest administrative units of Ethiopia) in southern Ethiopia (N = 462). The interventions were then tested in combination with a standard education intervention in a nonrandomised controlled trial, as follows: kebele 1, education intervention, namely an f-diagram exercise, (n = 23); kebele 2, education intervention and public-commitment (n = 122); kebele 3, education intervention and tippy-tap-promotion (i.e. handwashing-station-promotion; n = 150); kebele 4, education intervention, public-commitment and tippy-tap-promotion (n = 113). In kebeles 3 and 4, nearly 100% of the households followed the promotion and invested material and time to construct for themselves a tippy-tap. Three months after intervention termination, the tippy-taps were in use with water and soap being present in up to 83% of the households (kebele 4). Pre-post data analysis on self-reported handwashing revealed that the population-tailored interventions, and especially the tippy-tap-promotion, performed better than the standard education intervention. Tendencies in observed behaviour and a recently developed implicit self-measure pointed to similar results. Changing people's hand hygiene is known to be a challenging task, especially in a water-scarce environment. The present project suggests not only to apply theory and evidence to improve handwashing interventions' effectiveness, but also emphasizes the relevance of tailoring interventions to the target population.

Keywords: Handwashing · Diarrhoea · Respiratory diseases · Theory-based interventions · Evidence-based interventions · Population-tailored interventions · RANAS model · Ethiopia

Introduction

Improvements in hand hygiene efficiently prevent several major infectious illnesses, including diarrheal and respiratory diseases (Aiello et al., 2008; Cairncross et al., 2010a). These are still the main causes of death in children younger than five years globally (Black et al., 2010). In Ethiopia, where the two diseases account for 38% of deaths in children below the age of five and for 25% of disability-adjusted life-years (World Health Organization Regional Office for Africa, 2010), handwashing rates are considerably low as in most developing countries (Federal Ministry of Health Ethiopia, 2011; Scott et al., 2007). Effective handwashing programs are thus in great demand (Federal Ministry of Health Ethiopia, 2011; Global Public-Private Partnership for Handwashing with Soap, 2013).

Evidence-based interventions, namely interventions for which accepted empirical evidence of effectiveness is available (Davidson et al., 2003), are the exception in handwashing programs in developing countries (Aboud & Singla, 2012); more frequently implemented are interventions based on ‘best practice’ whose scope is often confined to educational approaches transferring knowledge (e.g. Global WASH Cluster, 2011). This comes into conflict with findings that health knowledge and risk awareness do not necessarily translate into handwashing (e.g. Aunger et al., 2010) and with studies questioning the effectiveness of educative handwashing interventions (e.g. Biran et al., 2009; Scott et al., 2007). Moreover, knowledge and risk perception are only of secondary importance in several major theories on health behaviour change (Conner & Norman, 2009b). Correspondingly, there is evidence for the superiority of theory-based health behaviour interventions that aim to change behaviour by influencing the behavioural determinants defined within a specific theory over those lacking a theoretical underpinning (e.g. Taylor et al., 2011; Webb et al., 2010; but see also Prestwich et al., 2013). Furthermore, as each single theory identifies only a subset of potentially crucial behavioural determinants, it has been suggested that interventions, to be most effective, should consider a range of relevant theories (Abraham, 2012; Lippke & Ziegelmann, 2008; cf. Aboud & Singla, 2012). In line with this, a more recent approach to behaviour change in the water, sanitation and hygiene sector in developing countries subsumes the behavioural determinants specified in leading theories of behaviour change into a comprehensive framework, the RANAS (Risk, Attitudes, Norms, Ability, Self-regulation) approach (Mosler, 2012). The incorporated theories are the health belief model (Rosenstock, 1974), protection motivation theory (Rogers, 1975), social cognitive theory (Bandura, 1977), the theory of planned behaviour (Fishbein & Ajzen, 2010), and the health action process approach (Schwarzer, 2008). The RANAS model categorises the factors specified in these theories into five broader factor groups; risk factors, attitude factors, norm factors, ability factors, and self-regulation factors (see Table 20 for an overview of the factor groups and definitions of the factors). All these factors potentially determine whether a behaviour is adopted or not and might thus be targeted within interventions. The RANAS model's core asset is that for each factor it depicts specific behaviour change techniques (BCTs; smallest active components of a behaviour change intervention, Michie & Johnston, 2012) which are thought to change exactly this factor (see Table 20 for the intervention mapping; cf. Abraham & Michie, 2008; Michie & Johnston, 2012; Michie et al., 2013). With that, it constitutes a solid basis for a theory- and evidence-based intervention selection.

What is more, the RANAS approach takes into account that the key factors determining a behaviour may differ between populations so that different interventions may be indicated for different populations. Accordingly, Mosler (2012) suggests applying interventions that are not only theory- and evidence-based but also population-tailored, meaning interventions that are matched to the key behavioural determinants in a specific population (cf. Aboud & Singla, 2012; Abraham, 2012; Bartholomew et al., 2006). To implement population-tailored interventions based on the RANAS approach, in a first step the key determinants of a specific behaviour in a specific population have to be assessed (e.g. by means of regression analysis). These factors, as they determine the behaviour in this population, are most likely to facilitate behaviour change and should thus be targeted in interventions. Therefore, in a second step the BCTs that are mapped in the RANAS model to exactly these determinants have to be selected for intervention development. In case that several factors emerged as similarly important determinants, those with unfavourable mean values should be targeted because these have a higher potential to change positively and therewith cause behaviour change (unfavourable mean values imply that the population's majority deviates from the ideal value, which is expected to facilitate behaviour change; e.g. on average beneficiaries feel low in self-efficacy and think that they are not able to always wash hands with soap at key times). In short, the RANAS approach's key assumption is that the most effective interventions are not only theory- and evidence-based but also population-tailored (Mosler, 2012).

Table 20. Overview of the factors subsumed in the RANAS model and the linked behaviour change techniques (adapted from Mosler, 2012)

Behaviour change techniques	Factor groups and factors' definitions
Information interventions • Presentation of facts/knowledge transfer • Personal risk information • Showing scenarios • Fear arousal	Risk factors • Perceived vulnerability (subjective perception of the individual risk of contracting a disease) • Perceived severity (subjective perception of the seriousness of a disease's individual consequences) • Factual knowledge (knowledge about a disease's causes and consequences and its prevention)
Persuasive interventions • Persuasive arguments • Persuasive peripheral cues • Affective persuasion	Attitude factors • Instrumental beliefs (a behaviour's advantages, e.g. health or status improvements, and disadvantages, e.g. time and monetary costs) • Affective beliefs (feelings arising when thinking about or performing a behaviour)
Normative interventions • Highlighting norms • Public commitment • Anticipated regret	Norm factors • Descriptive norm (behaviours typically practiced by others) • Injunctive norm (behaviours typically approved or disapproved by others) • Personal norm (personal standards about dos and don'ts)
Infrastructural and ability interventions • Knowledge transfer (education) • Guided practice • Facilitating resources (financing) • Social help • Modelling/vicarious reinforcement • Coping with barriers • Coping with relapse	Ability factors • Action knowledge (knowledge about how to perform a behaviour) • Motivational self-efficacy (confidence in one's ability to initiate and execute a behaviour) • Volitional self-efficacy (confidence in one's ability to maintain a behaviour in light of barriers and to recover from relapse) • Impediments (anticipated barriers and distractions to a behaviour)
Planning interventions and relapse prevention • Daily routine planning • Outcome feedback • Contingency management • Stimulus control • Forming implementation intentions • Prompts/Reminders	Self-regulation factors • Action control (self-monitoring and efforts carried out to execute a behaviour according to standards set for oneself) • Action planning (detailed planning of a behaviour's execution including the specification of 'when', 'where' and 'how') • Coping planning (establishing plans to overcome anticipated barriers and distractions to a behaviour) • Remembering (ease of remembering a behaviour at a specific time/in a specific situation) • Commitment strength (strength of commitment towards practicing a behaviour)

To test this assumption, the present project examined the effectiveness of theory- and evidence-based population-tailored handwashing interventions in comparison to a standard approach so as to contribute to a foundation of theory and evidence in health programs in developing countries (Aboud & Singla, 2012). For that, in a first step, the social-cognitive factors' determining handwashing in four kebeles (smallest administrative units of Ethiopia, similar to wards) in the Borena Zone, southern Ethiopia, were specified by means of a baseline data collection (see Figure 3). In a second step, interventions thought to affect these determinants were developed according to the RANAS model. In a final step, by means of a nonrandomised controlled trial with pre-post design the effectiveness of these population-tailored interventions was tested in the four Borena kebeles in comparison to a standard approach. In the following the overall method applied in this study is described before the results of steps 1 to 3 are presented. Where necessary, additional method sections are provided.

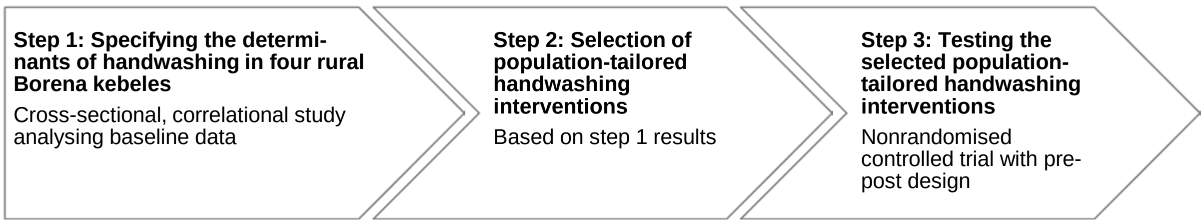

Figure 3. Overview of the research steps.

Overall method

Research area

The project was conducted with support of a local non-governmental organisation (NGO) working in four woredas (departments) in the Borena Zone. The region is semi-arid, with 70% of the area being sparsely wooded grassland (for the information presented in the following, see Debsu, 2013). The inhabitants, the Borenas, are semi-nomadic pastoralists with men seasonally migrating with their cattle. Since the 1970s, governmental organisations and NGOs have been working in the Borena Zone to mitigate recurring droughts, which threaten the survival of livestock and cause food insecurity and famine. Because disaster-affected people are particularly vulnerable to communicable diseases (including diarrhoea; Stanke, Kerac, Prudhomme, Medlock, & Murray, 2013; Wisner & Adams, 2002) parts of the emergency help were hygiene interventions. In 2006 the first handwashing intervention was implemented in the region. The conditions for promoting regular handwashing are extremely difficult due to the aridity and because water supply coverage is low. Mostly, long distances must be walked for water collection, so that families can often fetch only around 25 litres of water per day. Especially the women’s work burden is high, encompassing water collection, cooking, child care, and collecting fodder and fire wood.

Research designs

Data were collected in two waves, namely at baseline (six months prior to interventions) and follow-up (approximately three months after interventions). In step 1 a cross-sectional, correlational study was conducted by analysing the baseline data (see Figure 4). A nonrandomised controlled trial with three intervention arms and one control arm tested the population-tailored interventions in step 3 considering baseline and follow-up data (pre-post design).

Study population

While the local NGO worked in 28 kebeles across four woredas, the present study was limited to only four out of the twenty-eight kebeles due to the following. Security issues and logistical considerations restricted data collection to two out of the four woredas. Across these two woredas the local NGO was active in twelve kebeles but ongoing hygiene interventions by concurrent NGOs or limited accessibility led to the exclusion of eight kebeles. The inhabitants of the four remaining kebeles (two in each woreda) constituted the study population and the four kebeles served in step 3 as intervention arms. Within a kebele, each consisting of around 30 hamlets, only those hamlets were included which were reachable by car or a 20-minutes’ walk. Within a hamlet, households were randomly selected by the random-route-method (Hoffmeyer-Zlotnik, 2003). The eligibility criterion for participation, which was assessed by self-report, was being the primary caregiver of children younger than five years of age (usually the children’s mother or else their grandmother or older sister). These were targeted (1) because they are responsible for childcare and cooking and thus have the highest impact on transmitting diarrhoea and (2) because they may act as models and therefore influence the family’s hygiene behaviour.

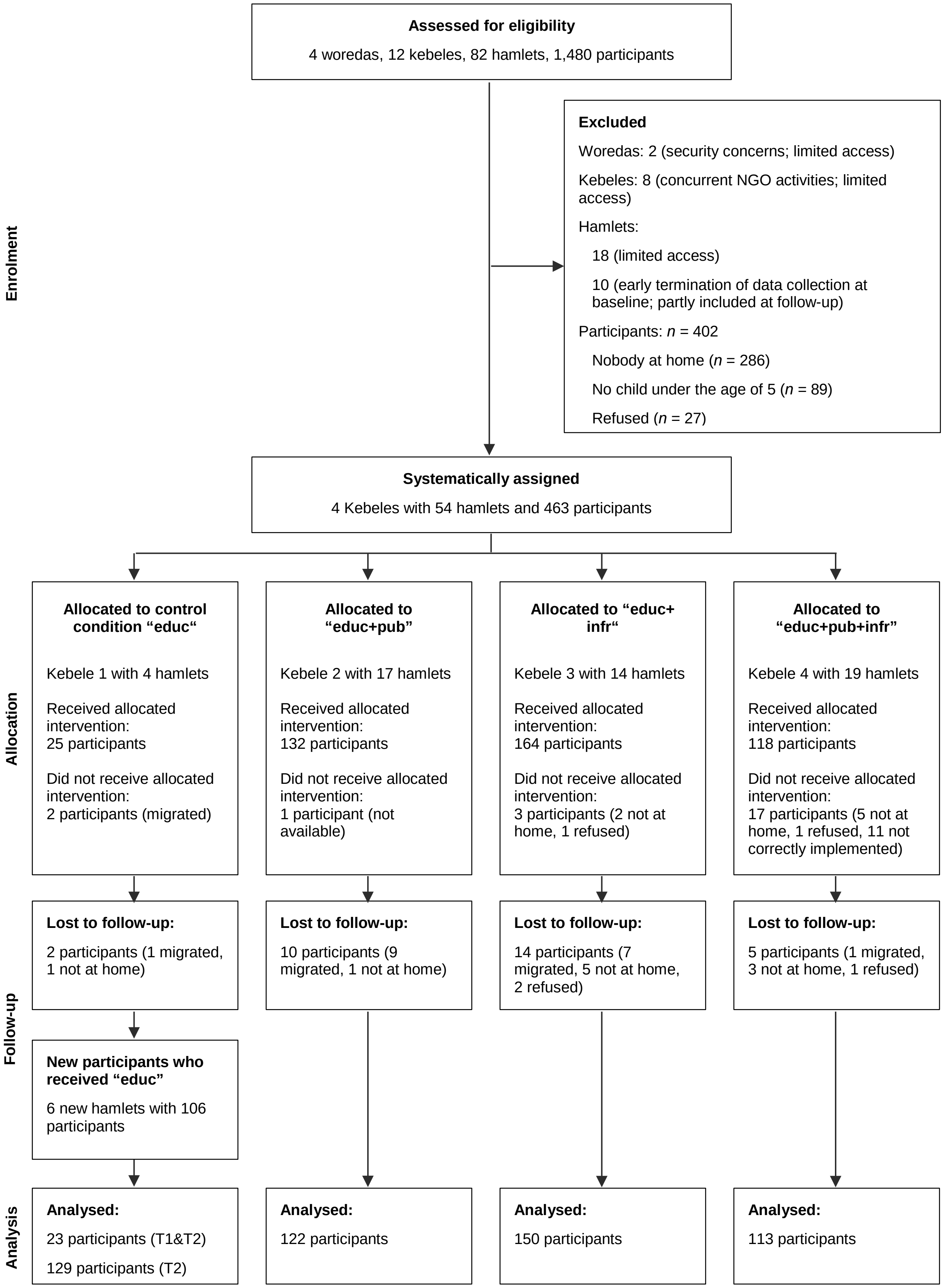

Figure 4. Flow chart of the study design.

Sample size estimation with G*Power 3.1 (Faul et al., 2009a) yielded a total sample size of 400 households to detect a small to medium effect in Cohen's f^2 at the Type I error probability of 0.05 and a statistical power of 0.95. Allowing for an attrition rate of 20% in the follow-up survey, we aimed to collect data from 500 randomly selected primary caregivers. Due to difficulties in data collection (i.e. inaccessibility of hamlets; high absence of potential participants; a limited timeframe causing an enormous work-overload and hence major exhaustion), the baseline survey had to be terminated earlier than planned resulting in only 462 study households. Of these, 23 did not receive the allocated interventions (5%) and 31 were not available for follow-up (7%; see Figure 4). Thus, in total, 408 primary caregivers were surveyed both at baseline and follow-up. Due to the untimely data collection termination at baseline, the control arm had a rather small sample size. Therefore, at follow-up, 106 additional participants were surveyed in the control arm.

According to expectations, all respondents were women. Most were married (baseline 86.8%; follow-up 89.9%) and the mothers of a child younger than five years in the household (baseline 85.1%; follow-up 85%). Their mean age was 34.27 years (SD = 13.89) at baseline and 34.37 years (SD = 13.66) at follow-up. The vast majority of the respondents had never attended school (baseline 97.6%; follow-up 96.9%) and were illiterate (baseline 97.2%; follow-up 98.4%). On average, study households comprised one child younger than five years ($M_{\text{baseline}} = 1.33$, $SD_{\text{baseline}} = 0.52$; $M_{\text{follow-up}} = 1.36$, $SD_{\text{follow-up}} = 1.07$). The mean income per person, per day was US $0.17 ($SD$ = 0.51) at baseline and US $0.18 ($SD$ = 0.05) at follow-up, which was far below the poverty line of US $1.25 (Ravallion et al., 2009). The vast majority of the respondents held traditional beliefs (baseline 96.7%; follow-up 94.7%).

Data collection procedure

Data were collected at baseline and follow-up by one-hour-long structured face-to-face interviews in Afan Oromo. In addition, household observations were conducted, that is data collectors observed primary caregivers' handwashing behaviour at key times (Ram, 2013). The observations lasted for three hours per household and preceded the interviews. At baseline only part of the study households were observed (n = 151), and observations started only at dawn. At follow-up, all study households were observed, and observations took place at dawn or around noon during lunch preparation. One-hundred-thirty-nine households were observed both at baseline and follow-up. Data were collected by teams of 10 (baseline) and 14 (follow-up) local students and social workers of which two were female. The teams were trained in interviewing and observation techniques in a 4-day workshop and supervised during data collection by researchers and a local collaborator.

Measures' overview

The interviews were based on a structured questionnaire developed for this study. The items covered socio-demographic characteristics, social-cognitive factors (used in step 1 only) and several outcome measures, namely self-reported handwashing, handwashing proxy-measures, and script-based covert handwashing recall (the latter two were used in step 3 only). The questionnaire was prepared in English, translated into Afan Oromo, and re-translated into English to ensure the quality of the translation. For the handwashing observations a structured format was prepared (Iyer et al., 2005; the measure was used only in step 3). The applicability of the questionnaire and the observation format was verified in a pre-test at baseline (N = 20) and follow-up of (N = 28). Table 21 provides an overview of all measures applied in this project. Self-reported handwashing, which was used in step 1 and 3, is described in the following. All other measures are described in the respective step.

Table 21. Overview of the applied measures in relation to the research steps and the time of measurement

	Research step and time of measurement	
Measures	Step 1	Step 3
Social-cognitive factors	Baseline data (n = 462)	
Self-reported behaviour	Baseline data (n = 462)	Baseline/follow-up data (n = 408)
Proxy measures		
Having a designated place		Baseline/follow-up data (n = 401)
Observed presence of water and soap		Follow-up data (n = 474)
Observed behaviour		
Stool-related handwashing		Baseline (n = 80)/follow-up (n = 214) data
Food-related handwashing		Baseline (n = 140)/follow-up (n = 502) data
Script-based covert handwashing recall		Follow-up data (n = 514)

Self-reported stool- and food-related handwashing. Self-reported handwashing was measured by eight items in the format 'In general, how frequently do you wash your hands with soap *before eating*/*after defecation*?'; its response options were 5-point Likert scales which were transformed into a value range of 0–1 (0 = almost never to 1 = almost always; Ram, 2013). Surveyed key times were those usually promoted in handwashing interventions focusing on diarrhoea prevention. Confirmatory factor analysis verified the separability of stool-related handwashing (SRH) and food-related handwashing (FRH; cf. Contzen & Mosler, 2013). For

SRH, the three surveyed key times were handwashing after defecation, wiping a child's bottom, and other kinds of contact with stool (Cronbach's α = .88). The five FRH key times were before eating, preparing food (i.e. cooking, cutting or preparing food), breastfeeding or feeding a child, and handling water (Cronbach's α = .89).

Human subject protection

As written informed consent was not attainable due to high illiteracy, verbal informed consent was obtained from every participant prior to data collection and interventions. The study was conducted in strict compliance with the ethical principles of the American Psychological Association (APA) and the Declaration of Helsinki and was approved by the Ethiopian National Research Ethics Review committee and the ethics board at the Faculty of Arts of the University of Zurich.

Step 1: Specifying the determinants of handwashing in four rural Borena kebeles

Step 1 addressed the following research question: Which factors determine handwashing with soap at key times in the Borena zone? To answer this research question, baseline self-reported SRH and FRH (see overall method section for the measurement information) and baseline social-cognitive factors (see below) were analysed.

Additional methods information

Social-cognitive factors' measures

Social-cognitive factors were measured according to suggestions in the RANAS approach (Mosler, 2012) and based on previous studies (Contzen & Mosler, 2013; Alexandra Claudia Huber et al., 2012; Inauen & Mosler, 2013). A part of the factors was measured separately regarding SRH and FRH and a great number of social-cognitive factors were considered. To keep the length of the interview acceptable it was unfeasible to apply multi-item scales for each construct. In line with the C-OAR-SE method (Rossiter, 2011), instead, mainly single-item measures were applied for which the primary selection criterion was maximal content validity while taking into account the local context. To capture multidimensional concepts multi-item-measures were used, namely one item per dimension. Where possible, these were averaged (see Appendix III, Table A-7 for sample items, Cronbach's alpha and descriptive statistics). With three exceptions (see Appendix III, Table A-7) the response options were

Likert scales (5-point for unipolar scales representing the “less” to “more” of a construct such as “not at all” to “very much”, and 9-point for bipolar scales representing a construct’s antipoles such as positive and negative). To ensure understanding, the answer scales for bipolar items were presented hierarchically. First, respondents were asked to select one of three broader categories (e.g. people rather disapprove, people are rather neutral, people rather approve). Then more detailed response options were presented (e.g. significantly more approve, most approve, nearly all approve). Further, for uni- and bipolar items, in case respondents did not select a specific category but stated a proper response (e.g. “most often they approve”), a specific answer was obtained by repeating the potential categories (e.g. “do you mean that most approve or nearly all approve”?). The categories were transformed into a value range of 0–1 (or −1 to 1 for bipolar items) in order to facilitate interpretation of the unstandardized regression coefficients.

Data analyses

All analyses were undertaken in IBM SPSS 22 separately for self-reported SRH and FRH. To select social-cognitive factors potentially relevant in explaining handwashing correlations with handwashing were inspected. As SRH and FRH were non-normally distributed Spearman correlations were calculated (Bishara & Hittner, 2012). Only those factors with significant correlations with handwashing higher than 0.20 were included in multiple regression analyses to identify the handwashing determinants. To increase estimation accuracy, the regression models were tested using bootstrap estimation with 10,000 resamples.

Results

On average, respondents reported washing their hands rather frequently, with mean levels of *Mdn* = 0.83 for SRH and *Mdn* = 0.80 for FRH. Table 22 presents the intercorrelations of all social-cognitive factors and handwashing. Due to correlations smaller than 0.20 with SRH or FRH nine and eleven factors, respectively, were excluded from further analyses: health knowledge; response efficacy; attraction; affective beliefs; action knowledge; action planning; coping planning regarding water, soap and forgetting; and, in terms of FRH, also disgust and motivational self-efficacy. Further, vulnerability was negatively correlated with behaviour, meaning that feeling vulnerable was correlated with lower behaviour frequency. The factor seemed thus unsuitable for an intervention and was also excluded from further analyses.

Table 22. Spearman correlations for SRH (below diagonal; *N* = 384) and FRH (above diagonal; *N* = 383) and social-cognitive factors

Variables	HW	Vul	Sev	HK	RE	Attr	Nurt	Affec	Disg	DN	IN	AK	MSE	VSE	Imp	AC	AP[a]	CPW	CPS	CPF	Forg	Com
HW		**-0.16**[b]	***0.32***	0.03	**0.10**[c]	**0.12**[c]	***0.27***	0.08	**0.13**[b]	***0.53***	***0.28***	0.01	**0.15**[b]	***0.26***	***-0.36***	***0.24***	0.00	**0.11**[c]	0.10	**0.11**[c]	***-0.36***	***0.22***
Vul	***-0.26***		**-0.11**[c]	0.10	**0.13**[c]	0.05	**0.12**[c]	**-0.16**[b]	0.00	**-0.12**[c]	**-0.12**[c]	**-0.13**[c]	-0.02	**-0.33**	**0.14**[b]	**-0.19**	**-0.13**[b]	**-0.16**[b]	-0.08	-0.09	**0.11**[c]	-0.04
Sev	***0.28***	**-0.12**[c]		**0.21**	**0.24**	**0.20**	**0.23**	**0.26**	**0.26**	**0.26**	0.02	**0.13**[c]	0.03	-0.05	**-0.24**	0.05	**0.13**[c]	0.01	-0.09	0.00	**-0.20**	-0.01
HK	0.00	0.09	**0.21**		**0.11**[c]	**0.12**[c]	-0.05	**0.19**	**0.11**[c]	-0.01	**-0.16**[b]	0.06	**-0.13**[c]	-0.09	-0.08	-0.08	0.08	0.10	0.10	**0.16**[b]	**-0.15**[b]	-0.07
RE	**0.12**[c]	**0.13**[c]	**0.24**	**0.11**[c]		**0.25**	**0.32**	0.07	**0.18**	**0.18**	0.07	**0.16**[b]	0.00	0.09	**-0.13**[c]	**0.14**[b]	0.05	-0.07	0.03	-0.08	**-0.18**	**0.16**[b]
Attr	**0.16**[b]	0.05	**0.19**	**0.12**[c]	**0.25**		**0.34**	**0.10**[c]	**0.17**[b]	**0.19**	-0.01	-0.01	**0.14**[b]	0.06	0.02	**0.14**[b]	0.02	0.07	0.05	0.01	0.00	**0.15**[b]
Nurt	***0.32***	**0.12**[c]	**0.23**	-0.05	**0.32**	**0.35**		0.03	**0.21**	**0.21**	0.01	0.02	**0.21**	0.07	-0.07	**0.21**	0.00	-0.07	-0.08	-0.08	-0.09	**0.28**
Affec	0.08	**-0.16**[c]	**0.26**	**0.19**	0.07	0.10	0.03		**0.21**	0.08	**0.10**[c]	**0.16**[b]	-0.02	-0.03	-0.03	0.08	**0.10**[c]	0.04	0.05	0.01	**-0.14**[b]	-0.01
Disg	***0.33***	**-0.11**[c]	**0.32**	**0.15**[b]	0.10	**0.15**[b]	**0.27**	**0.18**		0.03	-0.07	0.06	**0.14**[b]	**-0.14**[b]	-0.06	0.05	0.08	**-0.12**[c]	-0.07	-0.04	-0.06	0.14
DN	***0.48***	**-0.10**[c]	**0.19**	0.08	**0.16**[b]	**0.12**[c]	**0.20**	0.06	0.09		**0.38**	0.08	0.01	**0.35**	**-0.23**	**0.19**	-0.01	**0.20**	0.07	**0.10**[c]	**-0.22**	**0.28**
IN	***0.26***	**-0.13**[c]	-0.05	**-0.12**[c]	0.05	-0.05	0.00	0.07	0.00	**0.34**		0.03	0.06	**0.34**	**-0.15**[b]	**0.23**	0.05	**0.16**[b]	**0.15**[b]	-0.04	**-0.18**	**0.24**
AK	0.01	**-0.13**[c]	**0.13**[c]	0.06	**0.16**[b]	-0.01	0.02	**0.16**[b]	0.05	**0.11**[c]	0.02		-0.02	0.06	**-0.16**[b]	0.09	0.09	-0.02	-0.07	-0.05	-0.10	-0.02
MSE	***0.25***	-0.07	0.01	**-0.11**[c]	0.03	**0.12**[c]	**0.18**	-0.03	**0.17**[b]	0.05	**0.10**[c]	-0.02		0.02	-0.06	**0.19**	0.03	-0.05	-0.02	-0.03	**-0.14**[b]	**0.28**
VSE	***0.27***	**-0.33**	-0.05	-0.10	0.08	0.05	0.08	-0.03	0.02	**0.36**	**0.36**	0.05	-0.01		**-0.17**[b]	**0.39**	0.03	**0.33**	**0.34**	**0.18**	**-0.14**[b]	**0.23**
Imp	**-0.32**	**0.14**[b]	**-0.23**	-0.08	**-0.12**[c]	0.01	-0.08	-0.03	**-0.12**[c]	**-0.30**	-0.09	**-0.16**[b]	-0.03	**-0.17**[b]		-0.03	-0.09	**-0.13**[b]	0.02	-0.08	**0.57**	**-0.13**[c]
AC	***0.26***	**-0.18**	0.04	-0.08	**0.13**[c]	**0.13**[b]	**0.22**	0.07	0.09	**0.24**	**0.25**	0.09	**0.15**[b]	**0.39**	-0.04		0.09	0.10	**0.16**[b]	0.03	**-0.15**[b]	**0.21**
AP[a]	-0.02	**-0.13**[b]	**0.13**[b]	0.08	0.05	0.02	0.02	**0.10**[b]	0.00	0.01	0.04	0.09	0.04	0.04	-0.09	0.09		0.02	0.01	-0.02	0.00	-0.03
CPW	**0.17**[b]	**-0.17**[b]	0.01	0.09	-0.08	0.06	-0.06	0.04	-0.02	**0.21**	**0.16**[b]	-0.03	-0.06	**0.33**	**-0.13**[b]	**0.11**[c]	0.02		**0.30**	**0.15**	**-0.11**[c]	0.00
CPS	0.07	-0.07	-0.10	0.09	0.02	0.05	-0.07	0.05	-0.02	0.10	**0.20**	-0.06	0.00	**0.35**	0.01	**0.17**[b]	0.01	**0.31**		**0.12**[c]	-0.05	0.01
CPF	0.10	-0.08	0.00	**0.16**[b]	-0.08	0.01	-0.07	0.01	0.06	0.08	0.01	-0.05	-0.04	**0.19**	-0.09	0.03	-0.02	**0.15**[b]	**0.12**[c]		**-0.13**[c]	0.00
Forg	***-0.33***	**0.12**[c]	**-0.19**	**-0.14**[b]	**-0.18**	-0.01	-0.10	**-0.15**[b]	**-0.20**	**-0.32**	**-0.17**[b]	-0.10	**-0.14**[b]	**-0.14**[b]	**0.58**	**-0.16**[b]	0.00	**-0.10**[c]	-0.05	**-0.13**[b]		**-0.21**
Com	***0.37***	**-0.10**[c]	0.09	**-0.16**[b]	**0.15**[b]	**0.13**[c]	**0.34**	0.03	**0.24**	**0.24**	**0.23**	-0.01	**0.23**	**0.22**	**-0.13**[c]	**0.26**	0.06	-0.03	0.01	-0.06	**-0.19**	

Note. HW = Handwashing; Vul = Vulnerability; Sev = Severity; HK = Health knowledge, RE = Response efficacy; Attr = Attractiveness; Nurt = Nurture; Affec = Affective beliefs; Disg = Disgust; DN = Descriptive norm; IN = Injunctive norm; AK = Action knowledge; MSE = Motivational self-efficacy; VSE = Volitional self-efficacy; Imp = Impediments; AC = Action control; AP = Action planning; CPW = Coping planning – water; CPS = Coping planning – soap; CPF = Coping planning – forgetting; Forg = Forgetting; Com = Commitment strength. [a] Correlations are point biserial correlations. Coefficients in italic: correlation with handwashing $r > .20$. Coefficients in boldface: significant with $p \leq .001$, except for the following: [b] Significant with $p \leq .01$. [c] Significant with $p \leq .05$.

The descriptive statistics in Table 23 show that participants rated the severity of contracting diarrhoea as high. On average, participants were rather certain that they should wash their hands for their children's sake (nurture) and felt disgusted when not washing their hands at key times (disgust). Participants reported that around two-third of their community did wash their hands (descriptive norm) and stated medium-strength beliefs that others would approve of handwashing (injunctive norm). Regarding motivational self-efficacy, people were rather confident in their ability to perform handwashing at key times; their confidence in their ability (to restart) to wash hands in light of barriers or relapses, however, was only mediocre (volitional self-efficacy). On average, participants stated to be rather aware of their goal to wash hands and to put effort into it (action control). Impediments and forgetting hindered people in handwashing around once a day. The mean rating of commitment strength was rather high.

Results of the multiple regression analyses with SRH and FRH are presented in Table 23. Multicollinearity was acceptable (all variance inflation factors < 2). The tested social-cognitive factors explained SRH and FRH well. For both behaviours, the strongest predictors were descriptive norm, nurture, and severity. Additional influence had injunctive norm, impediments and action control. SRH was also predicted by disgust, motivational self-efficacy and commitment; FRH by forgetting.

In addition to these quantitative survey results, some qualitative observational findings are worth mentioning. First, a lack of any handwashing infrastructure (i.e. handwashing stations) in the study households became apparent. Instead, mugs or jugs were used for handwashing. Second, observations created the impression that forgetting to wash hands might be prevalent although participants claimed to forget it only around once a day; it seemed likely that people did not realize that they forgot to wash hands. Interestingly, although most of the participants had no coping strategy against forgetting or just stated to never forget (n = 417, 92.3%), some of the participants mentioned to put soap at a visible place or to put soap and water together as a reminder, which is a given when having a handwashing station (see below).

Based on these quantitative and qualitative results theory- and evidence-based population-tailored handwashing interventions were developed in step 2.

Table 23. Social-cognitive factors' intervention potential: descriptive measures and multiple regression results

	SRH (N = 461)					FRH (N = 462)				
	Descriptives		Multiple regression analysis			Descriptives		Multiple regression analysis		
Variable	M	SD	B	90% CI B	β	M	SD	B	90% CI B	β
Constant	–	–	-0.39***	[-0.53, -0.25]		–	–	-0.17*	[-0.32, -0.04]	
Severity	0.91	0.12	0.34***	[0.20, 0.47]	0.17	0.91	0.12	0.35***	[0.22, 0.47]	0.19
Nurture	0.79	0.17	0.35***	[0.25, 0.45]	0.24	0.79	0.17	0.28***	[0.18, 0.37]	0.21
Disgust	0.82	0.22	0.12**	[0.04, 0.20]	0.11	–	–	–		–
Descriptive norm	**0.63**	0.20	0.31***	[0.22, 0.40]	0.25	**0.65**	0.20	0.35***	[0.27, 0.42]	0.31
Injunctive norm	**0.71**	0.31	0.06*	[0.01, 0.11]	0.07	**0.72**	0.29	0.07*	[0.01, 0.13]	0.09
Motivational self-eff.	0.75	0.21	0.12**	[0.05, 0.20]	0.11	–	–	–		–
Volitional self-eff.	**0.59**	0.28	0.00	[-0.06, 0.05]	0.00	**0.60**	0.28	0.00	[-0.05, 0.05]	0.00
Impediments [a]	1.04	1.33	-0.03**	[-0.05, -0.01]	-0.16	1.04[e]	1.33	-0.08*	[-0.04, -0.00]	-0.11
Action control	0.75	0.16	0.14*	[0.03, 0.26]	0.10	0.75	0.16	0.16**	[0.06, 0.26]	0.11
Forgetting [a]	0.73	1.39	0.00	[-0.01, 0.02]	0.01	0.73[e]	1.39	-0.08*	[-0.03, 0.00]	-0.12
Commitment strength	0.77	0.20	0.11*	[0.03, 0.20]	0.09	0.78	0.19	0.02	[-0.07, 0.12]	0.02
			Adjusted R^2 =	.49				*Adjusted* R^2 =	.46	
			F =	41.30***				F =	44.44***	

Note. Bootstrap results with 10,000 resamples are presented. CI = Confidence interval. Means in boldface: suboptimal prevalence in community. [a] Answer scales ranged from 0 to infinite and are reverse coded, that is higher mean values represent higher improvement potential. * $p \leq .05$. ** $p \leq .01$.*** $p \leq .001$. One-tailed significance levels are presented except for the constant and F.

Step 2: Development of population-tailored handwashing interventions

According to the RANAS approach (Mosler, 2012), the most effective interventions are population-tailored, that means they target the key determinants of a behaviour in a specific population, especially those with unfavourable mean values; i.e. the social-cognitive factors with the highest intervention potential. Therefore, to develop population-tailored interventions for the four study-kebeles, the following research questions were addressed in step 2 based on the results of step 1: Which social-cognitive factors have the highest intervention potential? Which BCTs are expected to affect these factors and therewith to change behaviour?

The results of step 1 revealed that people with higher severity beliefs, stronger feelings of nurture, stronger descriptive and injunctive norms, higher action control beliefs and fewer impediments were more likely to wash hands at key times. Of the factors being substantially correlated with behaviour, the most unfavourable mean values were found for descriptive and injunctive norms and volitional self-efficacy (note that impediments and forgetting were reverse coded; i.e. higher means indicate high improvement potential). Combining the results on handwashing determinants and mean values, the highest intervention potential was found for descriptive norm, followed by injunctive norm and impediments.

In addition, qualitative observational findings suggested that forgetting was rather underestimated as people were not aware that they forgot to wash hands. Regarding other health behaviours (e.g. water treatment), forgetting is often traceable and becomes evident rather quickly and easily: If water filtering, for example, is forgotten, there is eventually an absence of filtered water, and forgetting is detected. Instead, forgetting to wash hands at a certain moment may never become salient. In short, qualitative observations indicated that forgetting might be a major obstacle to regular handwashing and should be taken into consideration.

The same is true for the current handwashing technique, namely using a mug or jug, which cannot be recommended. First, it is a rather inconvenient and time-consuming technique because (1) water is typically not readily available but has to be poured out of a jerry-can into a mug, (2) soap is often stored in a cupboard and not easily accessible either, and (3) only one hand at a time is free for handwashing (tippytap.org, n.d.). Second, washing hands with a mug uses 500 millilitres of water, versus 40 millilitres using a handwashing station (tippytap.org, n.d.).

In sum, results from step 1 suggested targeting the descriptive and injunctive norms, impediments, forgetting and the current handwashing technique by interventions. According to the RANAS model, several BCTs would have been conceivable to tackle these factors (Mosler, 2012; see Table 20) but three seemed especially promising: public commitment, facilitating resources and reminder. These were combined within two interventions; (1) a public-commitment intervention comprising public commitment and reminder, and (2) an infrastructure-promotion intervention comprising facilitating resources (i.e. construction of handwashing stations) and reminder.

In line with previous research (Inauen et al., 2014; Kraemer & Mosler, 2012), it was expected that committing publicly would increase the injunctive norm but also commitment strength, an additional handwashing determinant (see above; cf. Abraham, 2012; Abrahamse, Steg, Vlek, & Rothengatter, 2005; Lokhorst, Werner, Staats, van Dijk, & Gale, 2013; Mosler, 2012). Further, seeing others commit was assumed to enhance the descriptive norm (Mosler, 2012). Given that public-commitment is delivered with a sign, this should not only prolong the commitment process but might also serve as a reminder so as to lower forgetting (Tobias, 2009). To our knowledge, public-commitment has never been used to promote handwashing or hygiene; however, it has been successfully applied to promote other health behaviours (e.g. Kraemer & Mosler, 2012; Perlini & Ward, 2000) and pro-environmental behaviour (e.g. Lokhorst et al., 2013).

Having a handwashing infrastructure (i.e. a handwashing station) was expected to lower impediments by saving water and making soap and water easy accessible, and mitigate forgetting by serving as a reminder (Devine & Koita, 2010; Luby, Halder, et al., 2009; Scott et al., 2007; tippytap.org, n.d.). Given that handwashing stations are constructed outside the house, using the handwashing stations should transform the traditionally privately-performed handwashing behaviour into a publically-performed one, which was assumed to enhance the descriptive norm (Curtis et al., 2009; Scott et al., 2007). Further, the energy, time, and costs publicly invested in its construction might strengthen households' commitment to using the handwashing station, and elevate others' expectations, increasing the injunctive norm. Finally, using a handwashing station would alter the handwashing technique, that is ease behaviour performance (Biran, 2011; Curtis et al., 2009), which was expected to increase self-efficacy, an additional handwashing predictor. The intervention selection is supported by previous research showing that a designated place and facility for handwashing (i.e. a handwashing station) is correlated with higher levels of handwashing (Biran, Tabyshalieva, &

Salmorbekova, 2005; Devine & Koita, 2010). Quantitative evaluations of handwashing station interventions are rare; however, the intervention was successfully implemented to promote handwashing around school children (Zhang, Mosa, Hayward, & Matthews, 2013).

The two selected handwashing interventions, i.e. public-commitment and infrastructure-promotion, were tested in step 3 in comparison with an education-control.

Step 3: Testing population-tailored handwashing interventions

Step 3 addressed the following research question: Are population-tailored interventions more effective in changing handwashing behaviour than a standard approach (i.e. an education intervention)? To answer the question, a nonrandomised controlled trial with pre-post design was conducted. Intervention effects were expected to be smaller for education compared to education combined with public-commitment (educ+pub; H1), education combined with infrastructure-promotion (educ+infr; H2), and education combined with public-commitment and infrastructure-promotion (educ+pub+infr; H3). In addition, the study assumed that educ+pub+infr would yield more behaviour change than educ+pub (H4) and educ+infr (H5).

Additional methods information

Interventions were implemented from October 2012 to January 2013 in the Borena Zone. The four study kebeles served as parallel intervention arms and were non-randomly assigned by the first author and NGO representatives to the control or one of the three intervention conditions (see Figure 4). In all four arms, an education intervention was administered. The two interventions under study were applied in a full factorial design. In arm 1, the control group, only educ was implemented; arm 2 received educ+pub; arm 3 received educ+infr; and arm 4 received educ+pub+infr. Reporting of the nonrandomised controlled trial follows the Transparent Reporting of Evaluations with Nonrandomised Designs (TREND) statement (Des Jarlais, Lyles, & Crepaz, 2004).

Interventions

One female and nine male health promoters employed and supervised by the local NGO were responsible for the implementation of the interventions, which were delivered during community meetings from October 2012 to January 2013. To each meeting, 20–30 primary caregivers of one or several hamlets in a kebele were invited through home visits during which the interventions' object and content was explained. The interventions were approved by the kebele leaders and elders, who explicitly endorsed participation. The interventions are described in brief as follows. Detailed descriptions can be found in Appendix III.

Education intervention. As an education intervention, the f-diagram exercise, an often applied intervention tool (e.g. David, Mumuni, & Awuku, 2009; Global WASH Cluster, 2011), was implemented by means of a one-hour group sorting task at a community meeting.

Public-commitment intervention. Referring to previous research (Inauen & Mosler, 2013) community meetings were held at which primary caregivers gave an oral pledge of their commitment to always wash hands at key times. A commitment sign (i.e. a head scarf, see Figure 5) and a certificate were distributed.

Infrastructure-promotion intervention. Instead of simple provision, households were encouraged to construct a family handwashing station by themselves to enhance the commitment for use, namely a tippy-tap (see Figure 5 and Appendix III for more detail on the tippy-tap). Construction took place right after a community meeting at which the construction was demonstrated, and jerry-cans used for the station were distributed.

A functional handwashing station implies continuous presence of water and soap. Therefore, inspired by research on the importance of preparatory behaviours in condom use (such as buying condoms; e.g. Empelen & Kok, 2008) and on planning-interventions (Hagger & Luszczynska, 2014), in half of the households with infrastructure-promotion a supplementary intervention was implemented, the so-called maintenance-planning intervention. During home visits, to assure a continuous provision of water and soap at the tippy-tap, primary caregivers of these households were encouraged to establish a routine regarding when to fill water and when to check if soap has to be replaced. To facilitate remembering of the routines a planning file was completed (see Appendix III, Maintenance planning file). As most of the beneficiaries were illiterate, the file's content was delivered by pictures and text in unison. The other half of the households with infrastructure-promotion did not receive any additional intervention or visits.

Figure 5. Handwashing interventions in the Borena zone.
Left: A primary caregiver wearing the public commitment scarf. Right: A tippy tap constructed by one of the research households.

Intervention supervision. To maximise fidelity, all interventions were specified by detailed written instructions provided by the first author. The promoters were trained in a two-day workshop outlined by the first author and held by supervisors of the local NGO, a local research collaborator and representatives of a collaborating international NGO. The supervisors, supported by the local collaborator, assisted the promoters throughout the interventions and ensured quality by field visits and by revising delivery documentation (i.e. monitoring and attendance forms).

Outcome measures

Main outcome measure in step 3 was change in self-reported handwashing. To get a more detailed picture of the interventions' effects, however, several additional outcome measures were applied.

Change in self-reported SRH and FRH. To examine changes in self-reported handwashing from baseline to follow-up, baseline values were subtracted from follow-up values for each individual. Response scales ranged from -1 = 100% reduction in handwashing over 0 = 0% change in handwashing to 1 = 100% increase in handwashing. These change scores elucidate the extent and direction of change but do not reveal the absolute value in behaviour.

Handwashing proxy-measures. As approximations for handwashing behaviour, participants were asked whether they have a designated place and facility for handwashing (yes/no; Ram, 2013). In addition, at follow-up only, participants were asked to show their designated place for handwashing or – in case no such place existed – to show their most common place for handwashing; data collectors recorded whether water and soap was present (neither/only one/both present; Ram, 2013).

Coping planning. To evaluate the maintenance-planning intervention, at follow-up households were asked about their coping-plans to always have water and soap at home for handwashing. These were categorized as being in line with maintenance-planning (such as filling the tippy-tap on a daily basis or buying soap every market day) or being not in line with maintenance-planning (such as asking a neighbour for water or soap).

Script-based covert handwashing recall. At follow-up, in addition to conventional self-reports, a script-based covert handwashing recall was developed and applied. Short sequences of daily routines representing handwashing key times (i.e. scripts) were presented to the respondents, who were asked to explain in as much detail as possible how they usually carry out these routines. Because respondents were not explicitly asked about their handwashing behaviour (i.e. covert), it was expected that this measure would be little affected by socially desirable responding. Further, asking for a course of events (i.e. scripts) instead of a single target event is said to ease the recall of the target event (Weisberg, 2005). An example item would be:

> Imagine you have just finished feeding the goats. Now your child is hungry and you have to feed it. Please describe exactly what you do from leaving the goats' house until you feed the child.

Data collectors recorded whether the respondent mentioned handwashing with soap during the description of their routine. Four items were applied for SRH and FRH each and were later averaged. Sum-scores ranged from 0 = handwashing mentioned at 0% to 1 = handwashing mentioned at 100%.

Observed handwashing. The same key times as those measured by self-reports were observed (see overall method). In case a key event occurred, it was noted in a structured format along with the information on whether both hands were washed with water before or after the event and whether soap was used. During data processing, observed handwashing was calculated for each type of key event separately (e.g. food preparation; different steps in food preparation were counted as one event unless unrelated behaviours were performed in between two steps) as the percentage of times both hands were washed with soap out of all the times handwashing would have been necessary (e.g. food was prepared). Analogous to the self-reports, observational data concerning stool or food were averaged to form observed SRH and FRH. Response scales ranged from 0 = 0% handwashing to 1 = 100% handwashing. While 139 households were observed both at baseline and follow-up, not all key events occurred in all 139 observed households during observation. As a result, longitudinal data for stool-related events were available for only 38 primary caregivers and only one was out of the control arm. With 136 longitudinally observed events, data availability was better for food-related behaviours; however, only six originated from the control arm. As a consequence, observational data could not be used for the main longitudinal analyses. Rather, these had to be realized by using self-reported data.

Data analyses

To get an initial evaluation of the interventions' effects, chi-square tests were applied to check whether frequencies in proxy-measures at baseline and follow-up (having a designated place and facility for handwashing) or at follow-up only (observed presence of water and soap at the designated or most common place for handwashing) were associated with the intervention arms. Analyses testing for differences at baseline and follow-up were controlled for the familywise error rate (Bender & Lange, 2001) by means of Bonferroni adjustment ($\alpha' = 0.025$). Chi-square tests were also applied to investigate differences between households with and without maintenance-planning regarding coping-plans and the presence of soap and water. For all chi-square tests, in case of significant results, contingency tables with standardized residuals were inspected to determine the arms with the highest differences between observed and expected frequencies.

To investigate tendencies in change in observed handwashing behaviour between intervention arms, means in observed SRH and FRH were computed for baseline and follow-up.

Between-subjects multivariate analysis of covariance (MANCOVA) was conducted to test for group differences between the intervention arms with regard to change in self-reported SRH and FRH. These were followed up by separate univariate analyses of covariance (ANCOVAs) with Bonferroni adjustment ($\alpha' = 0.025$; Bender & Lange, 2001) . To test H1 to H5, planned simple contrasts compared the control arm to the three educ+ arms and the full intervention arm to educ+pub and educ+infr.

Because the script-based covert handwashing recall measure violated the assumptions for parametric tests, Kruskal-Wallis tests with Bonferroni adjustment ($\alpha' = 0.025$; Bender &

Lange, 2001) were applied to investigate group differences. To test H1 to H5, these were followed-up by five Mann-Whitney tests with Bonferroni adjustment ($\alpha' = 0.01$; Bender & Lange, 2001) for SRH and FRH each that compared the control arm to the educ+ arms and the full intervention arm to educ+pub and educ+infr.

Results

Intervention fidelity

With regard to the public-commitment intervention, despite intervention supervision, some protocol deviations were noted. More precisely there are indications that the intended link between the head scarf and commitment was not communicated properly. The researchers' main idea of introducing a commitment sign was that people would express their commitment to the community by wearing the scarf so as to continuously trigger social norms. As a side benefit it was expected that the scarf would serve as a reminder. However, there is anecdotal evidence that in the promoter-training the reminding-function was more emphasized than the commitment-function. Consequently, conveyed to the communities was primarily that the scarf serves as a reminder. Further, in the educ+pub arm, there is evidence to suggest that in some cases the basic idea of wearing the scarf to foster handwashing was completely overridden: respondents said that they were told to wear the scarf to be given a lift or simply to always wear the scarf when people from outside visited the kebele. That is, the link between scarf and handwashing was removed, rendering the scarf impotent for eliciting handwashing.

Preliminary analyses

With regard to differences between intervention arms, no differences were found in socio-demographics. However, intervention arms differed in self-reported baseline behaviour. As these baseline differences are not taken into account within the change scores, the baseline values were entered as covariates in the MANCOVA on changes in self-reported behaviour. Attrition did not differ between arms, and no significant differences in socio-demographics, social-cognitive factors and observed and self-reported behaviour were found between study remainders and dropouts. Further, participants who were observed at baseline did not differ in socio-demographics, social-cognitive factors or self-reported behaviour from those who were not observed.

Initial intervention assessment: Differences in proxy-measures

In the infrastructure-promotion arms, 94% (educ+pub+infr) and 99% (educ+infr) of the households actually constructed a tippy-tap. That is, almost 100% considered the promotion and invested material and time in the construction.

At baseline, only few respondents stated to have a designated place and facility for handwashing (typically the place where the jerry-can with water and a jug was stored; see Table 24). The occurrence was associated with the intervention arms, χ^2 (3) = 22.99, $p < .001$, Cramer's $V = 0.24$; that is, of those with a designated place and facility significantly more than expected were located in the educ+pub arm; for the other arms expected and observed frequencies did not differ. At follow-up, occurrence was again associated with the intervention arms, χ^2 (3) = 301.59, $p < .001$, Cramer's $V = 0.86$; that is, in the educ and educ+pub arm significantly *less* households than expected and in the infrastructure-promotion arms significantly *more* households than expected (almost 100%) stated to have a designated place and facility for handwashing, what supports in tendency H2 to H4 (see Table 24). Thus, in the latter arms, nearly 100% not only constructed a tippy-tap, but also recognized it as their designated place for handwashing.

Table 24. Households with a designated place and facility for handwashing at baseline and follow up: Frequency in percent per intervention condition and standardized residuals

	n (SR)				
Designated place	Educ	Educ+pub	Educ+infr	Educ+infr+pub	Total *n*
Baseline					
No	100% (0.4)	82.6% (-1.1)	95.8% (0.4)	96.5% (0.5)	370
Yes	0% (-1.3)	17.4% **(3.8)**	4.2% (-1.5)	3.5% (-1.6)	31
Follow-up					
No	100% **(5.6)**	84.3% **(9.9)**	0% **(-6.9)**	6.2% **(-5.0)**	132
Yes	0% **(-3.9)**	15.7% **(-6.9)**	100% **(4.8)**	93.8% **(3.5)**	269
Total *n*	23	121	150	113	401

Note. SR = Standardized residuals. Values in italics represent (marginally) significant standardized residuals. Values outside +/-1.96 are marginally significant at $p < .05$; values outside +/-2.24 are significant at the Bonferroni adjusted $\alpha' = 0.025$.

Associations with intervention arms were also found for observed presence of water and soap at the designated or most common place for handwashing (see Table 25), χ^2 (3) = 81.39, $p < .001$, Cramer's $V = 0.29$. In the educ+infr arm water and soap were observed in significantly more households than expected while the opposite is true for the educ+pub and educ arms, supporting in tendency H2.

Table 25. Households with observed water and soap present at the designated or most common place for handwashing: Frequency in percent per intervention condition and standardized residuals

	n (SR)				
Water and soap	Educ	Educ+pub	Educ+infr	Educ+infr+pub	Total *n*
None	28.2% (1.8)	28.2% (1.8)	3.4% **(-4.6)**	27.7% (1.7)	96
Only one of both	35.0% (1.9)	33.6% (1.7)	13.4% **(-2.9)**	25.0% (-0.1)	121
Both	36.9% **(-2.4)**	38.2% **(-2.3)**	83.2% **(4.8)**	47.3% (-1.0)	257
Total *n*	103	110	149	112	474

Note. SR = Standardized residuals. Values in italics represent significant standardized residuals. Values outside +/-1.96 are significant at $p < .05$; values outside +/-2.58 are significant at $p < .01$; values outside +/-3.29 are significant at $p < .001$.

Effects of the maintenance-planning

Intervention arms with infrastructure-promotion were investigated regarding maintenance-planning. In terms of coping-plans, the percentage of responses in line with maintenance-planning did not differ between participants who experienced and those who did not experience maintenance-planning, water-related coping χ^2 (1) = 0.85, p = .355, Cramer's V = 0.06 and soap-related coping χ^2 (1) = 0.37, p = .545, Cramer's V = 0.04. With regard to observed presence of soap and water at the designated or most common place for handwashing, again, no differences were found between respondents who experienced maintenance-planning (69%) and those who did not (65%), χ^2 (2) = 5.44, p = .066, Cramer's V = 0.14.

Differences in observed behaviour

Figures 6 and 7 show the mean rates in observed SRH and FRH. These have to be interpreted with caution, especially for the educ arm for which baseline sample size is minimal.

In arms with infrastructure-promotion, observed SRH was substantially higher at follow-up than at baseline. In the control arm (educ), the handwashing rate was also higher at follow-up compared to baseline (where the handwashing rate was 0%), but still lower than the rates in arms with infrastructure-promotion. In contrast to expectations, in the educ+pub arm, the handwashing rate was lower at follow-up than at baseline.

Observed FRH was rather low in all intervention arms and, against expectations, it was even lower at follow-up than at baseline. This drop was somewhat more pronounced in the educ+pub and the educ arms (see discussion).

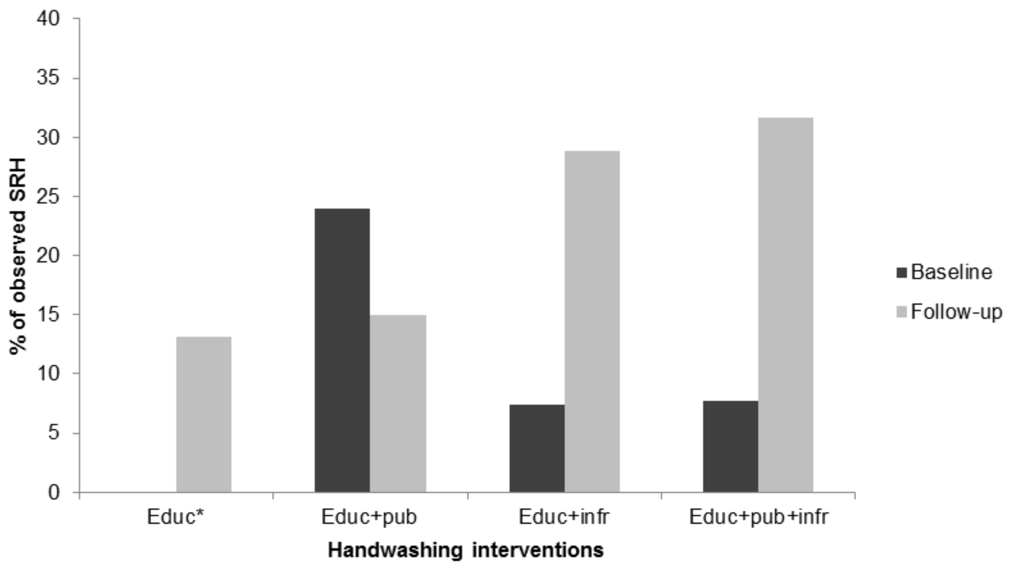

Figure 6. Mean rates in observed SRH.

Sample sizes were as follows: Educ *n* baseline = 2, *n* follow-up = 61; educ+pub *n* baseline = 25, *n* follow-up = 60; educ+infr *n* baseline = 27, *n* follow-up = 52; educ+pub+infr *n* baseline = 26, *n* follow-up = 41. * Rate was zero at baseline.

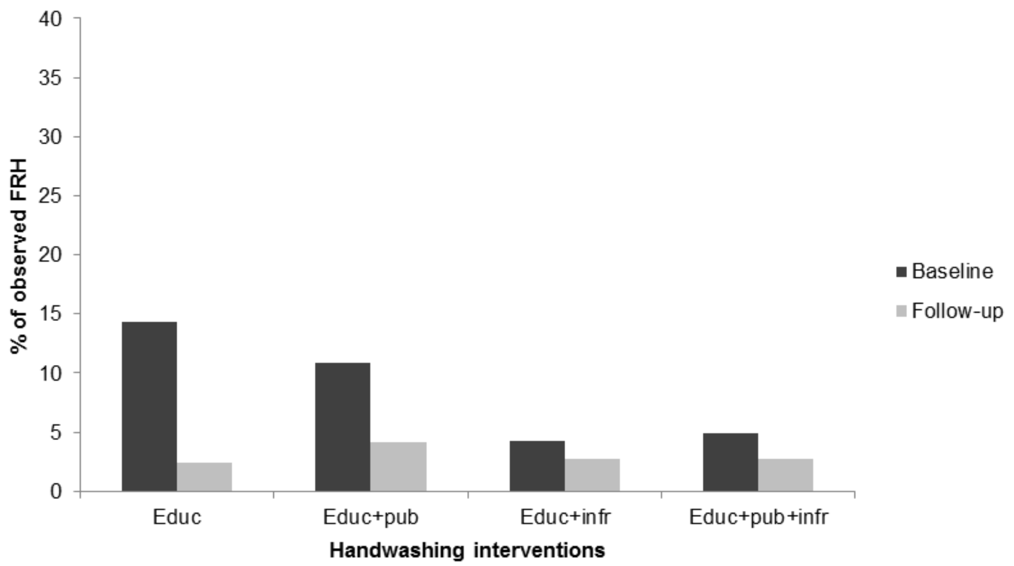

Figure 7. Mean rates in observed FRH.

Sample sizes were as follows: Educ *n* baseline = 7, *n* follow-up = 125; educ+pub *n* baseline = 46, *n* follow-up = 119; educ+infr *n* baseline = 46, *n* follow-up = 148; educ+pub+infr *n* baseline = 41, *n* follow-up = 110.

Changes in self-reported behaviour

Changes in self-reported handwashing are presented in Table 26. While small positive changes were found for educ+pub+infr, behaviour did not change for educ+infr. Unexpectedly, behaviour decreased slightly for educ+pub and more pronouncedly in the control arm (educ).

Table 26. Descriptive statistics for changes in self-reported handwashing[a] and contrast results

				Contrasts with					
				Educ			Educ+pub+infr		
	n	*M*	*SD*	Diff	*p*	90% CI[c]	Diff	*p*	90% CI
Stool-related HW									
Educ	23	-0.19	0.37		–			–	
Educ+pub	122	-0.10	0.29	0.11	.029	[0.01, 0.20]	-0.07	.013	[-0.13, -0.02]
Educ+infr	150	0.01	0.33	0.17	.001	[0.08, 0.26]	-0.01	.349	[-0.06, 0.04]
Educ+pub+infr	113	0.08	0.33	0.18	<.001	[0.09, 0.27]		–	
Food-related HW									
Educ	23	-0.23	0.34		–			–	
Educ+pub	122	-0.15	0.27	0.10	.028	[0.01, 0.19]	-0.11	<.001	[-0.17, -0.06]
Educ+infr	150	-0.02	0.34	0.19	<.001	[0.11, 0.28]	-0.02	.214	[-0.07, 0.03]
Educ+pub+infr	113	0.09	0.31	0.22	<.001	[0.13, 0.30]		–	

Note. [a] Variable ranging from −1 = *100% reduction in handwashing* over 0 = *0% change in handwashing* to 1 = *100% increase in handwashing*. One-tailed significance levels are presented. CI = Confidence interval; in accordance with the one-tailed significance levels, 90% CIs are presented.

A MANCOVA tested for differences between intervention arms while controlling for baseline behaviour. Wilks' statistic revealed a significant effect of the promotion activities on changes in self-reported handwashing, $\Lambda = 0.94$, $F(6, 802) = 4.45$, $p < .001$, $\eta^2 = .03$. The covariates achieved significance insofar as high baseline behaviour was associated with *less* positive behaviour change, baseline SRH $\Lambda = 0.68$, $F(2, 401) = 95.90$, $p < .001$, $\eta^2 = .32$ and baseline FRH $\Lambda = 0.67$, $F(2, 401) = 100.29$, $p < .001$, $\eta^2 = .33$.

Separate univariate ANCOVAs on changes in self-reported handwashing behaviour revealed significant intervention effects on SRH, $F(3, 402) = 4.77$, $p = .003$, $\eta^2 = .03$ and FRH, $F(3, 402) = 8.79$, $p < .001$, $\eta^2 = .06$. In line with H1 to H3, simple contrasts revealed that changes in SRH and FRH were significantly more positive in all educ+ arms compared to the educ arm (see Table 26). Further, behaviour changes in educ+pub+infr were more positive compared to changes in educ+pub, supporting H4. In contrast to H5, however, changes in educ+pub+infr and educ+infr did not differ significantly from each other. The largest differences were found between educ and educ+pub+infr, with large effect sizes of $d = 0.77$ for SRH and $d = 0.98$ for FRH.

Differences in script-based covert handwashing recall

Median rates in SRH and FRH were highest for the two infr arms and lowest for the educ arm (see Table 27). Kruskal-Wallis tests showed that handwashing was significantly affected by the intervention arms, SRH, $H(3) = 33.33$, $p < .001$ and FRH, $H(3) = 29.28$, $p < .001$. Follow-up Mann-Whitney tests revealed that in contrast to H1 handwashing was only marginally significantly (SRH) or not significantly (FRH) higher in educ+pub than in educ (see Table 27). However, in both infr-arms handwashing was significantly higher compared to educ, supporting H2 and H3. Further, in educ+pub+infr handwashing was also (marginally) significantly higher when compared to educ+pub, supporting H4, but not when compared to educ+infr, what contradicts H5.

Table 27. Descriptive statistics for script-based covert handwashing recall[a] at follow-up and results from Mann-Whitney tests

			Mann-Whitney with							
	n	*Mdn*	Educ				Educ+pub+infr			
			U	*z*	*p*[b]	*r*	*U*	*z*	*p*[b]	*r*
Stool-related HW										
Educ	129	0.00		–				–		
Educ+pub	122	0.25	6749.50	-2.07	.019	-.13	5851.50	-2.09	.018	-.14
Educ+infr	150	0.50	6195.50	-5.39	<.001	-.32	7835.50	-1.09	.139	-.07
Educ+pub+infr	113	0.50	5301.50	-3.85	<.001	-.25		–		
Food-related HW										
Educ	129	0.00		–				–		
Educ+pub	122	0.20	7129.50	-1.38	.083	-.09	5700.50	-2.39	.008	-.16
Educ+infr	150	0.40	6535.50	-4.87	<.001	-.29	8045.50	-0.72	.236	-.04
Educ+pub+infr	113	0.40	5305.00	-3.84	<.001	-.25		–		

Note. Variable ranging from 0 = *0% handwashing* to 1 = *100% handwashing.* [b] Bonferroni adjusted $\alpha' = 0.01$. One-tailed significance levels are presented.

Discussion

The present project tested the assumption that handwashing interventions that are not only theory- and evidence-based but also tailored to the target population (i.e. geared to the key behavioural determinants in a specific beneficiary-population) are more effective than standard interventions (Mosler, 2012). This was done by means of three steps: (1) defininghandwashing determinants in four Borena kebeles, southern Ethiopia; (2) specify related behaviour change techniques (BCTs) to develop population-tailored interventions; and (3) test the population-tailored interventions in the four kebeles.

Step 1 revealed descriptive norm, injunctive norm and impediments as key determinants of handwashing. This is in line with previous research emphasizing the importance of social norms and impediments in promoting handwashing (Aunger et al., 2010; Curtis et al., 2009; Devine et al., 2012; Luby, Halder, et al., 2009). Interestingly, vulnerability was found to be negatively correlated with behaviour. While this result is contrary to expectations, it is in line with previous research on other health behaviours (Norman et al., 2009) and may be explained by reverse causality: people who do wash their hands – that is take precautions – feel less vulnerable to diarrhoea. Further, qualitative results suggested tackling the current handwashing technique, which was washing hands with a mug or jug, and to mitigate forgetting. In step 2, to target these factors, based on the RANAS model (Mosler, 2012) three BCTs were selected: public-commitment, facilitating resources, and reminder. These were combined in two interventions, a public-commitment intervention (comprising public-commitment and reminder) and an infrastructure-promotion intervention (comprising facilitating resources, i.e. tippy-tap/handwashing-station-promotion, and reminder).

Their effectiveness was tested in step 3 in comparison to an education-only intervention, an f-diagram exercise, in a nonrandomised controlled trial. In terms of infrastructure-promotion in combination with education (and with or without public-commitment), households not only accepted the invitation to construct a tippy-tap in high numbers, but also they recognized the tippy-tap as their designated place for handwashing. Additionally, in nearly 50–80% of the households, the tippy-tap was functioning, with water and soap being present. This is quite substantial, especially when considering that the interventions had ended three months prior to follow-up. In contrast, in groups having experienced education-only or in combination with public-commitment, water and soap was present at the place where they most often washed their hands in less than 40% of the households. Results referring to observed handwashing were mixed. Infrastructure-promotions seemed to have positively affected stool-related handwashing (SRH); the same is true to a smaller extent concerning education-only. Education combined with public-commitment, however, seemed to have a negative effect on SRH. Food-related handwashing (FRH) decreased for all intervention arms but less so for the infrastructure-promotion arms. Self-reported behaviour and script-based covert recall revealed a clearer picture, with lowest behaviour (change) in the education-only arm, followed by education combined with public-commitment, and highest behaviour (change) in infrastructure-promotion arms.

Combining the results, evidence is provided that the theory- and evidence-based, population-tailored interventions (public-commitment and/or infrastructure-promotion) outperformed the education-only intervention. Therewith, the power of population-tailored interventions is emphasized (Mosler, 2012; cf. Abraham, 2012) and today's common practice in handwashing interventions, namely educational approaches, is questioned. The result is in line with previous research on well-switching in Bangladesh (Inauen & Mosler, 2013) and corresponds to a recent appeal to bring more theory and evidence into health programs in developing countries while simultaneously adjusting interventions to its audience (Aboud & Singla, 2012). Further, the infrastructure-promotion intervention proved to be most effective in enhancing handwashing rates (for further discussion of the public-commitment intervention, see below). Similarly, Zhang and colleagues (2013) found more behaviour change among school children when providing a tippy-tap compared to education-only. The infrastructure-promotion intervention's positive effects are also in line with previous research showing that handwashing station ownership is correlated with higher levels of handwashing (Biran et al., 2005; Devine & Koita, 2010).

Maintenance-planning, applied to establish a routine regarding when to fill water and when to check if soap has to be replaced, seemed not to add to the positive effect of the infrastructure-promotion. For maintenance-planning to be effective, it seems crucial that the stated plans are specific and realistic. It may be that some of the plans did not meet these criteria, which would lower the effectiveness of this intervention. Further, to fulfil its intervention potential, the maintenance-planning file should serve as a reminder to actually implement the plans. The file, being a monochrome print, might have been inappropriate to awaken attention and thus serve as a prompt. Future studies should address these issues by investigating how specific and realistic the established plans are, and by using eye-catching maintenance-planning files.

In line with previous research and our expectations, the education-only intervention did not seem to be effective for changing behaviour (Biran et al., 2009; Scott et al., 2007; Zhang et al., 2013). Unexpectedly, however, self-reported handwashing even *decreased* in the education-only arm. There are two possible explanations for the decrease; (1) the intervention had no impact and (2) it had a negative one. The first explanation starts with the argument that a natural decrease in behaviour might have been at play in all research arms, explained as follows. In all four kebeles baseline data collection was preceded by a one-year handwashing promotion program that was planned and implemented independent of the present research project by the collaborating international and local NGOs. The applied interventions focused mainly on knowledge-formation and awareness-raising but also included material distributions (i.e. water buckets and soap). The key message conveyed to the beneficiaries was to wash hands with soap after defecation, before food preparation, before eating, and before breastfeeding or feeding a child. It may be assumed that due to this foregoing promotion program handwashing rates were rather high at baseline (especially as so many interventions had been applied) and decreased subsequently because the induced behaviour change was unsustainable (cf. Arnold et al., 2009; Luby, Agboatwalla, et al., 2009). The presently tested education intervention, assumed to be ineffective, was incapable of slowing this decline; therefore behaviour *decreased* in the education-only arm. (While the same argument could explain why education plus public-commitment was associated with behaviour decrease (see below for more detail), it seems that only the infrastructure-promotion intervention successfully mitigated the behaviour decline.)

Alternatively, the education intervention may have had a genuinely negative impact, explained as follows. The education intervention, meaning the f-diagram exercise, assessed the route of contamination as a whole. That is, it depicted not only how handwashing can prevent diarrhoea, but also how, amongst other things, sanitation and safe water are crucial. These are not comprehensively guaranteed in the area. It is credible that the sheer number of changes necessary and their potential infeasibility over-challenged the participants that experienced only the f-diagram. This is in line with research showing that fear (aroused by stressing vulnerability and severity, which is done in the f-diagram exercise) results only in protective behaviour when there is confidence in the own ability to perform the protective behaviour (i.e. self-efficacy; see Bartholomew et al., 2006). Lack of confidence, however, brings people to react defensively and may even lead to threat denial; that is, in our case, participants might have waived behaviour change instead of focusing on the feasible changes. This reasoning would imply that the f-diagram exercise should be implemented in combination with an intervention that enhances self-efficacy, such as the infrastructure-promotion. Indeed, research arms with infrastructure-promotion performed well, while education plus public-commitment, which is not thought to enhance self-efficacy, performed poorer (see below). To our knowledge, although often applied, the f-diagram exercise has never been formally tested. An in-depth analysis of the f-diagram exercise would be valuable.

While there is some evidence that the education plus public-commitment intervention was more effective than education-only, a behaviour decrease, although smaller, was also found for the former intervention. The first explanation outlined above for the education-only intervention may also explain this result (i.e. public-commitment had no impact). Further, it can be reasoned that public-commitment *without* infrastructure-promotion was not effective because it was combined with the f-diagram exercise that aroused fear, which was not positively transformed into behaviour change due to a lack of self-efficacy (see above). It is less credible that public-commitment may have had a genuinely negative impact. If it were the public-commitment intervention in itself that caused the decrease, the infrastructure-promotion with public-commitment should have performed poorer than the infrastructure-promotion without public-commitment, which was not the case. However, it may be that the intervention was unsatisfactorily implemented in the education plus public-commitment arm and was accordingly inappropriate to fulfil its potential and to slow down a natural behaviour decline – see (1) above. In fact, it was exactly in the education plus public-commitment arm where most concerns around implementation fidelity had arisen (see results above). The potential of the public-commitment intervention is thus uncertain. This contrasts research in other fields, where public-commitment was successfully applied (e.g. Kraemer & Mosler, 2012; Lokhorst et al., 2013; Perlini & Ward, 2000). Still, one very recent study also found detrimental effects of a public-commitment intervention on well-switching in Bangladesh (Inauen & Mosler, 2013). Further research is required to test the potential of a public-commitment intervention in hygiene.

Strengths and limitations

The key strength of this study is the application and testing of population-tailored interventions. Further, to our knowledge, this is (1) the first study providing quantitative evidence of the effectiveness of a tippy-tap-promotion intervention in increasing handwashing among rural women, (2) the first application of a public-commitment intervention to promote handwashing, and (3) the first quantitative test of the f-diagram exercise.

While gearing the interventions to the key determinants of handwashing in the study population and to the specific local context contributes majorly to the study's uniqueness, at the same time it limits the results' generalizability.

As a further shortcoming, intervention allocation was not randomised. A randomised controlled trial (i.e. allocation of interventions to households) was not feasible because the interventions were public (public commitment and handwashing stations constructed at publicly visible places) so that information contamination would have been risked; interventions had to be allocated to clusters. A limited number of study kebeles precluded the implementation of a cluster-randomised controlled trial. For this reason, cluster effects might have blurred intervention effects. While we tried to level this shortcoming by controlling for baseline values in the MANCOVA, a replication by means of a cluster-randomised controlled trial would be preferable.

Due to premature termination of the baseline data collection, the control arm was small in sample size with regard to self-reported handwashing. This may have decreased the power to detect substantial intervention effects (Cohen, 1992). The fact that despite the small sample size significant effects were found emphasizes the relevance of these effects.

Moreover, in terms of observed behaviour, the total baseline sample was rather small, which limited the options for conducting analyses with these data. Consequently, the main analyses relied on self-reported behaviour although it has been suggested to observe handwashing behaviour to minimize bias due to socially desirable responding (Biran et al., 2008; Halder et al., 2010). However, because self-reported handwashing is associated with child diarrhoea and pneumonia, child (diarrhoea) mortality, and cholera (Hutin, Luby, & Paquet, 2003; Luby, Halder, Huda, Unicomb, et al., 2011; Rhee et al., 2008; Silk et al., 2010; Water Sanitation and Hygiene Research Group, 2012), it is relevant to be examined. Further, all participants, including those in the control condition, received an intervention and should thus have been equally inclined to socially desirable answers. Hence, if self-reported handwashing was solely contingent on social desirability, a behaviour *increase* should have been reported in all conditions. However, what was found were increases, decreases, and stability in self-reported handwashing. Moreover, additionally applied measures (such as proxy-measures or script-based covert handwashing recall) all pointed in the same direction. Still, the absolute handwashing rates in this study should be interpreted with caution, and future studies should aim at replicating the results by means of observational data.

Conclusions

Improved hand hygiene might save millions of children's lives (Aiello et al., 2008; Cairncross et al., 2010a), but changing handwashing behaviour is a challenging task, especially in water-scarce environments. In the present project, handwashing interventions that were based on theory and evidence and were tailored to the target population, namely primary caregivers from rural, water-scarce kebeles in southern Ethiopia, performed better than a standard education intervention. The tippy-tap-promotion is especially promising as it enables participants to regular behaviour by means of a tangible handwashing device that eases behaviour performance, saves water, makes soap and water readily available, serves as a reminder, and enhances social norms (Biran, 2011; Devine & Peschiera, 2010; Scott et al., 2007; tippytap.org, n.d.). The research project emphasizes the importance of applying theory and evidence, combined with insights about the target population and environment, to improve common practice in handwashing interventions (Aboud & Singla, 2012).

Additional information

Appendix III contains additional information about the social-cognitive factors' measurement, detailed interventions' descriptions, and the maintenance planning file.

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Chapter II – Social cognitive factors mediating intervention effects on handwashing: A longitudinal study

Nadja Contzen & Jennifer Inauen

Abstract

Objectives. Handwashing with soap at key times effectively prevents diarrhoea, a leading cause of death in children under the age of five years. Theory-based interventions are expected to promote handwashing more successfully than standard approaches, and they allow the identification of the mechanisms of change. The objective of this study was to investigate the underlying change processes of two handwashing interventions based on the RANAS (Risk, Attitudes, Norms, Abilities and Self-regulation) approach.

Design. A nonrandomised controlled trial with four arms was conducted to compare an education-only intervention to two theory-based interventions that were matched to the target population's needs.

Methods. Primary caregivers of randomly selected household (N = 462) of four kebeles (smallest administrative units of Ethiopia) in the Borena Zone, Ethiopia, participated in this study. One intervention arm was allocated to each kebele: education only; education and public commitment; education and infrastructure-promotion; and education, public commitment and infrastructure-promotion. Handwashing behaviour, social-cognitive factors, and socio-demographic characteristics were assessed at baseline and at 3-month follow-up by structured face-to-face interviews. Mediation analysis was used to investigate the underlying change processes.

Results. In comparison to education only, education with public commitment effectively changed social norms and thus handwashing. Education with an infrastructure-promotion (i.e. handwashing-station-promotion) effectively changed social norms, self-efficacy, impediments, forgetting and commitment strength and was thus most successful in changing behaviour.

Conclusions. The study emphasizes not only the relevance of using theory to inform health behaviour change interventions but also highlights the importance of matching interventions to a target population. The results confirm the relevance of testing interventions' underlying change processes.

Keywords: Handwashing interventions · Diarrhoea · Social-cognitive factors · Behaviour change · Mediation analysis

Introduction

Diarrhoea is a leading cause of death in children under five years in Ethiopia (World Health Organization Regional Office for Africa, 2010) and globally (Black et al., 2010). The single most effective preventive measure against childhood diarrhoea is primary caregivers' handwashing with soap at key times, namely before contact with food and after potential contact with stool (Cairncross et al., 2010b; for the distinction between food- and stool-related handwashing, see also Contzen & Mosler, 2013). In spite of its preventive power, handwashing is uncommon in Ethiopia and in most developing countries (Curtis et al., 2009; Federal Ministry of Health Ethiopia, 2011), and also remains a challenge in developed countries, e.g. in healthcare settings (e.g. Bittner et al., 2002; Miller, Yardley, & Little, 2011; Pessoa-Silva et al., 2007) and pandemics (e.g. Updegraff et al., 2011; Yardley et al., 2011). Core tasks of health promoting agencies are therefore developing and implementing handwashing programs. However, their efficacy is often mixed (Aboud & Singla, 2012; Naikoba & Hayward, 2001; S. Wilson, Jacob, & Powell, 2011). To increase the effectiveness of health behaviour change interventions, scholars advocate using behavioural theories to inform them (Aboud & Singla, 2012; Al-Tawfiq & Pittet, 2013; Michie & Johnston, 2012). As each theory identifies only a subset of potentially relevant behavioural determinants to intervene on, maximal effectiveness is expected when multiple theories are considered (Abraham, 2012; Lippke & Ziegelmann, 2008). In addition to assess the efficacy of such theory-based interventions, it is essential to test their underlying change processes (Michie & Abraham, 2004). Therewith, we can extend the still limited evidence base of strategies to change specific behavioural determinants and also better understand *why* a strategy was (in)effective, which helps to improve it (Abraham, 2012; Lippke & Ziegelmann, 2008).

This study tested the change processes of two handwashing interventions in Ethiopia. Both interventions were selected in accordance with the results of a baseline study applying the RANAS (Risk, Attitudes, Norms, Abilities, Self-regulation) approach, a multi-theoretical framework to design water, sanitation and hygiene (WASH) interventions in developing countries (Mosler, 2012). While the detailed results of the baseline study are presented elsewhere (Contzen, Meili, & Mosler, 2015), in the following, the RANAS approach and the main results of the baseline study are briefly presented.

Selecting social-cognitive factors to intervene on based on the RANAS approach

To facilitate intervention development in WASH, the RANAS approach (Mosler, 2012) provides a model summarizing the social-cognitive factors specified in leading theories of behaviour change, such as social cognitive theory (Bandura, 2004) or the health action process approach (Schwarzer, 2008), combined with a taxonomy matching specific behaviour change techniques (BCTs) to these factors (cf. Michie et al., 2008; Michie et al., 2013). In the RANAS model, the factors are grouped into five factor blocks, risk factors, attitude factors, norm factors, ability factors and self-regulation factors. Table 28 provides an overview of the considered factors, their definitions and the linked BCTs.

The approach constitutes a solid basis for a theory- and evidence-based intervention selection. It further acknowledges that the key social-cognitive determinants may differ between behaviours and between populations. Consequently, different interventions may be indicated for different behaviours or different populations. Therefore, the RANAS approach (Mosler, 2012) also suggests to select population-tailored interventions, that is interventions which are matched to a behaviour in a specific population (cf. Abraham, 2012; Bartholomew et al., 2006). In brief, the idea of the RANAS approach is to (1) identify the social-cognitive factors with the highest potential to intervene on for a specific behaviour in a specific population based on a structured survey, and (2) to select BCTs which are linked to exactly these factors for intervention development (Mosler, 2012; for an example study see Inauen & Mosler, 2013). According to the RANAS approach, the factors with the highest potential to intervene on are the key determinants of a behaviour in a specific population (to be assessed for example by correlation or regression analysis), which are in addition most changeable with regard to facilitating behaviour change (to be assessed by analysing the factors' mean values in the population, where low values indicate high positive changeability).

The RANAS approach was applied in four kebeles (smallest administrative units of Ethiopia) in the Borena Zone, Ethiopia. A baseline study identified the social-cognitive factors of handwashing with the highest potential to intervene on (for more details see Contzen et al., 2015). Quantitative results suggested to primarily target the descriptive and injunctive norms (cf. Cialdini et al., 2006) and impediments (cf. Bandura, 2004; for definitions see Table 28 and for more details see Contzen et al., 2015).

Table 28. Overview of the social-cognitive factors subsumed in the RANAS model and the linked behaviour change techniques (adapted from Mosler 2012)

Behaviour change techniques	Factor groups and factors' definitions
Information interventions • Presentation of facts/knowledge transfer • Personal risk information • Showing scenarios • Fear arousal	Risk factors • Perceived vulnerability (subjective perception of the individual risk of contracting a disease) • Perceived severity (subjective perception of the seriousness of a disease's individual consequences) • Factual knowledge (knowledge about a disease's causes and consequences and its prevention)
Persuasive interventions • Persuasive arguments • Persuasive peripheral cues • Affective persuasion	Attitude factors • Instrumental beliefs (perceived advantages, e.g. health or status improvements, and disadvantages, e.g. time and monetary costs) • Affective beliefs (feelings arising when thinking about or performing a behaviour)
Normative interventions • Highlighting norms • Public commitment • Anticipated regret	Norm factors • Descriptive norm (behaviours typically practiced by others) • Injunctive norm (behaviours typically approved or disapproved by others) • Personal-norm (personal standards about dos and don'ts)
Infrastructural and ability interventions • Knowledge transfer (education) • Guided practice • Facilitating resources (financing) • Social help • Modelling/vicarious reinforcement • Coping with barriers • Coping with relapse	Ability factors • Action knowledge (knowledge about how to perform a behaviour) • Motivational self-efficacy (confidence in one's ability to initiate and execute a behaviour) • Volitional self-efficacy (confidence in one's ability to maintain a behaviour in light of barriers and to recover from relapse) • Impediments (anticipated barriers and distractions to a behaviour)
Planning interventions and relapse prevention • Daily routine planning • Outcome feedback • Contingency management • Stimulus control • Forming implementation intentions • Coping with barriers • Coping with relapse • Prompts/Reminders	Self-regulation factors • Action control (self-monitoring and efforts carried out to execute a behaviour according to standards set for oneself) • Action planning (detailed planning of a behaviour's execution including the specification of 'when', 'where' and 'how') • Coping planning (establishing plans to overcome anticipated barriers and distractions to a behaviour) • Remembering (ease of remembering a behaviour at a specific time/in a specific situation) • Commitment strength (strength of commitment towards practicing a behaviour)

This is in line with previous research revealing social norms and impediments as key determinants of handwashing in developing countries (e.g. Curtis et al., 2009; Devine et al., 2012). For the latter, especially a lack of readily accessible soap and water in the right places and at the righttimes seems hindering (Curtis et al., 2009; Devine & Koita, 2010; Luby, Halder, et al., 2009). Related to that, a qualitative assessment of the handwashing situation in the four Borena kebeles during the aforementioned baseline study (Contzen et al., 2015) revealed a lack of handwashing infrastructure and a potentially hindering handwashing technique employing mugs or jugs. This technique cannot be recommended as it is rather inconvenient and time-consuming, because (1) water is typically not readily available but has to be poured out of a jerry-can into a mug, (2) soap is often stored in a cupboard and not easily accessible, and (3) only one hand at a time is free for handwashing (cf. tippytap.org, n.d.). Hence, a quick and easy handwashing performance seems difficult, so that people may not succeed to *regularly* wash their hands at key times and thus may not achieve mastery experience. Mastery experience, however, is a crucial source of both motivational and volitional self-efficacy; the belief in one's capability to initiate and execute a behaviour, and to maintain it and to recover from relapse respectively (Bandura, 1998; Schwarzer, 2008). Correspondingly, previous research suggest that self-efficacy related to handwashing in developing countries might be especially low in situations in which one has to deal with many things at once (e.g. food preparation, intruding animals and child care) as well as with regard to important, unplanned tasks, such as soothing the crying baby by feeding it (Affleck & Pelto, 2012; Curtis et al., 2009). Further qualitative observations during the baseline study suggested forgetting as an additional hampering factor, which was also found in previous studies (Affleck & Pelto, 2012; Curtis et al., 2009). According to Tobias (2009), a behaviour is only executed when it is feasible (e.g. low impediments and high self-efficacy), preferred (e.g. positive norms), and *remembered*. With regard to handwashing forgetting might be exceptionally decisive (1) because handwashing must take place in predefined situations and one cannot compensate later, and (2) because forgetting handwashing leaves no traces and may never become salient.

To sum up, the baseline study suggested to target the following determinants to promote handwashing in four kebeles in Ethiopia: descriptive and injunctive norms, impediments, forgetting and the present handwashing technique which might limit self-efficacy (cf. Contzen et al., 2015).

Mechanisms of change to promote handwashing with soap

To target the specified social-cognitive factors, the RANAS approach (Mosler, 2012) offers three particularly promising BCTs: public commitment, facilitating resources, and reminders. These were combined within two interventions: (1) a public commitment intervention comprising public commitment and a reminder, and (2) an infrastructure-promotion intervention comprising facilitating resources (i.e. construction of handwashing stations) and a reminder. The assumed effects of the two interventions on the selected social-cognitive factors are described in the following.

Making a commitment, defined as "an oral or written pledge or promise to change behaviour" (Abrahamse et al., 2005, p. 275), given to oneself or the public, is a widely used BCT (Lokhorst et al., 2013). In accordance to the RANAS approach (Mosler, 2012), this study expected that public commitment would increase commitment strength and the injunctive norm (see also Abrahamse et al., 2005; Lokhorst et al., 2013). Both effects have been verified in previous research (Inauen et al., 2014; Kraemer & Mosler, 2012). In addition, it assumed that seeing others commit would affect the descriptive norm (Mosler, 2012). Provided the public commitment was delivered as a sign, it should serve as a reminder, and thus lower forgetting (Mosler, 2012; Tobias, 2009).

Based on the RANAS approach (Mosler, 2012), it was expected that the promotion of a handwashing infrastructure would affect impediments, forgetting, self-efficacy, commitment and social norms. In more detail, it was assumed that having a handwashing infrastructure (i.e. a handwashing station) should decrease impediments by making water and soap easily accessible, and lessen forgetting by serving as a reminder (cf. Devine & Koita, 2010; Luby, Halder, et al., 2009; Scott et al., 2007). Also, a handwashing station introduces a handwashing technique which is quick and easy because of the ready availability of water and soap and because both hands are free for handwashing (cf. Biran, 2011; Curtis et al., 2009; tippytap.org, n.d.). It is expected that using the handwashing infrastructure thus allows mastery experience of *regular* handwashing and therewith increases self-efficacy (Bandura, 1998; Mosler, 2012). Further, the energy, time, and costs publicly invested in its construction might strengthen households' commitment to using the handwashing station, and elevate others' expectations, increasing the injunctive norm. Finally, given that handwashing stations are constructed outside the house, using the handwashing stations should transform the traditionally privately-performed handwashing behaviour into a publically-performed one, which was expected to enhance the descriptive norm (Curtis et al., 2009; Scott et al., 2007).

The aim of this study was to test the two interventions' underlying behaviour change processes. The study assumed that both population-tailored interventions, compared to a control group, would promote handwashing by enhancing the descriptive norm (H1), the injunctive norm (H2), and commitment strength (H3), and by mitigating forgetting (H4). The infrastructure-promotion was additionally expected to increase handwashing by enhancing motivational and volitional self-efficacy (H5 and H6), and decrease perceived impediments (H7).

Methods

The above hypotheses were tested in a nonrandomised controlled trial with a pre-post-test design and four arms (see Figure 8). An education intervention was implemented in all arms, including the control group. This follows the idea to apply a strong comparison group that incorporates some intervention components instead of a pure control or contact control condition to test the interventions of interest more rigorously (Williams, 2010). Arm 1, the control group, received the education intervention only (educ); arm 2 received education and public commitment (educ+pub); arm 3 received education and the infrastructure-promotion (educ+infr); and arm 4 received education, public commitment and infrastructure-promotion (educ+pub+infr).

The study was conducted in strict compliance with the ethical principles of the American Psychological Association (APA) and the Declaration of Helsinki. It received ethical approval from the Ethiopian National Research Ethics Review committee and the Faculty of Arts of the University of Zurich. Informed consent was obtained from every participant prior to interviews and interventions. Reporting followed the Transparent Reporting of Evaluations with Nonrandomised Designs (TREND) statement (Des Jarlais et al., 2004).

Research area

The study was conducted from February 2012 to March 2013 in the Borena Zone in southern Ethiopia. The Borena Zone is a semi-arid region recurrently hit by droughts causing food insecurity and famine (Debsu, 2013). Handwashing interventions have been implemented in the region since 2006 as part of the repeated drought emergency responses.

Clusters and participants

The study was implemented in cooperation with a local NGO who was working in 28 kebeles across four Borena departments. However, the present study was limited to only four of these kebeles. First, security issues and logistical considerations restricted data collection to two out of the four departments. Further, across these two departments the local NGO was active in twelve kebeles but ongoing hygiene interventions by concurrent NGOs or limited accessibility led to the exclusion of eight kebeles. The remaining four kebeles were non-randomly assigned by the first author and NGO representatives to arms 1-4 (see Figure 8). Each kebele consisted of around 30 hamlets; only those that were reachable by car or a maximum 20-minute walk were included in the study. Within each hamlet, households were randomly selected by the random-route method (Hoffmeyer-Zlotnik, 2003).

The eligibility criterion for participation was being a primary caregiver (usually a woman) of children under the age of five. Primary caregivers were targeted because they are responsible for childcare and cooking, and thus, have the highest chance of transmitting diarrhoea. In addition, they may act as models and accordingly influence the family's hygiene behaviour.

Sample size estimation with G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009b) suggested a survey of 400 households to detect a medium effect at the Type I error probability of 0.05 and a statistical power of 0.95. Allowing an attrition rate of 20%, the study aimed to interview 500 primary caregivers. In total, only 462 baseline interviews were conducted due to difficulties in data collection. Of these, 23 did not receive the allocated interventions (5%) and 31 were not available for follow-up (7%; see Figure 8). Thus, in total, 408 primary caregivers were interviewed at both times, had received the allocated interventions, and were subsequently analysed.

As expected, all interviewees were women. Their mean age was 35.52 years (SD = 14.19). The vast majority of the respondents had never attended school (n = 396, 97.1%) and were illiterate (n = 399, 97.8%). On average, study households comprised one child under the age of five (M = 1.34, SD = 0.52). The mean income per person, per day was US $0.17 ($SD$ = 0.19), which was far below the poverty line of US $1.25 (Ravallion et al., 2009).

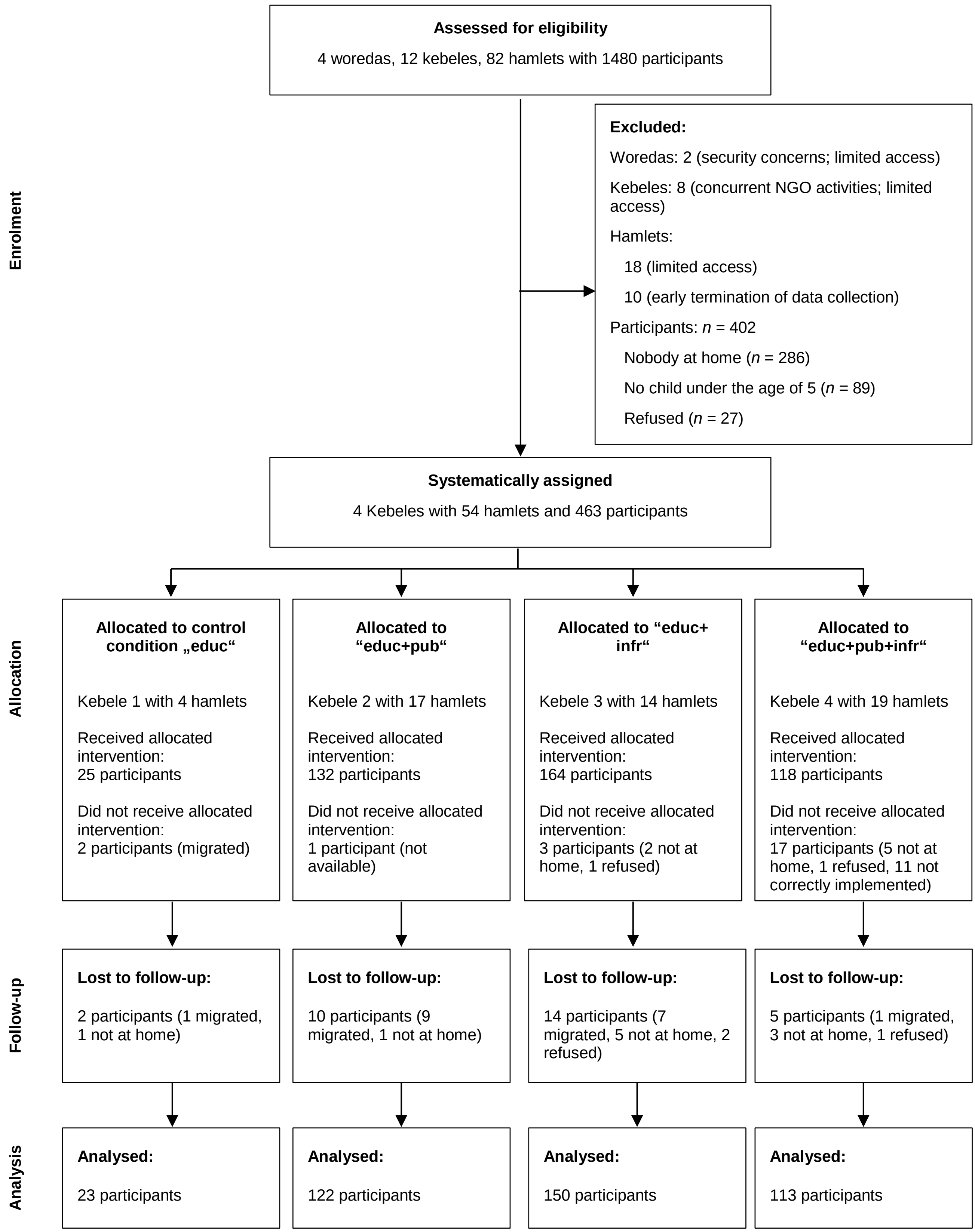

Figure 8. **Flow chart of the study design.**

Data collection method

Data were collected at baseline (six months prior to interventions; these data were used for intervention development briefly presented in the Introduction; for more detail see Contzen et al., 2015) and follow-up (approximately 3 months after interventions) by one-hour-long, structured, face-to-face interviews in Afan Oromo at the respondents' homes. The interviews were conducted by teams of 10 (baseline) and 14 (follow-up) local students andsocial workers of which two were female. The team was trained in interviewing techniques in a 4-day workshop, and supervised during data collection by researchers and the local collaborator.

Measures

A structured questionnaire was developed for this study; it covered self-reported handwashing, social-cognitive factors, and socio-demographic characteristics. Most of the questionnaire items were derived from the RANAS model (Mosler, 2012) and previous studies (Contzen & Mosler, 2013; Alexandra Claudia Huber et al., 2012; Inauen & Mosler, 2013). Some of the factors of the RANAS were measured both regarding stool- and food-related handwashing separately (see below). To keep the length of the interview acceptable it was therefore unfeasible to apply multi-item scales for each factor. To assure the measures' validity nonetheless, the items were constructed in line with the C-OAR-SE method (Rossiter, 2011). In line with this method, mainly single-item measures were applied for which the primary selection criterion was maximal content validity while taking into account the local context. To capture multidimensional concepts multi-item-measures were used, that is for each dimension one item was applied. With two exceptions (see below), the response options were Likert scales (5-point for unipolar items and 9-point for bipolar items), which were transformed into a value range of 0–1 (or −1 to 1 for bipolar items) to facilitate interpretation of the unstandardized regression coefficients. The questionnaire was prepared in English, translated into Afan Oromo, and re-translated into English to ensure the quality of the translation. Its applicability was verified in a pre-test of N = 20. The following presents example questions for each construct and internal consistencies (baseline/follow-up).

Stool- and food-related handwashing

Self-reported handwashing was measured by eight items in the following format: 'In general, how often do you wash your hands with soap *before eating*/*after going for defecation*?' (0 = *almost never* to 1 = *almost always*). Self-reported handwashing has been criticised to be biased by socially desirable responding. However, it may still be seen as valid outcome measure as it has been found to be associated with critical health effects, such as child diarrhoea (e.g. Luby, Halder, Huda, Unicomb, et al., 2011; for more details see the discussion). Surveyed key times were those usually promoted in handwashing interventions focusing on diarrhoea prevention (e.g. Luby, Halder, Huda, & Johnston, 2011; for more details see the discussion), that is after defecation, wiping a child's bottom or other kinds of contact with stool (stool-related handwashing, SRH); before eating, preparing food, breastfeeding or feeding a child, and handling drinking water (food-related handwashing, FRH). The finding from previous research that SRH and FRH are statistically separable (and partly explained by different behavioral factors; Contzen & Mosler, 2013), was verified in the present study by confirmatory factor analysis. Internal consistencies were satisfactory (Cronbach's α SRH [baseline/follow-up] = .88/.90, Cronbach's α FRH [baseline/follow-up] = .89/.91).

Social-cognitive factors

Descriptive norm. One item for SRH and one item for FRH were applied. People were asked, 'How many people of your community wash hands with water and soap *bhf/acws*?' (0 = *almost nobody* to 1 = *almost all of them*).

Injunctive norm. Stool- and food-related injunctive norms were measured with two items each. Respondents were asked, for example, 'Do people who are important to you rather think you should or you should not wash your hands with soap and water *bhf/acws?*' (-1 = *nearly all think I should not* to 1 = *nearly all think I should*; Cronbach's α stool [baseline/follow-up] = .78/.55; Cronbach's α food [baseline/follow-up] = .77/.58).

Motivational self-efficacy. This was assessed with one item each for SRH and FRH. People were asked whether they felt able to always wash hands with soap and water *before handling food (bhf)/after contact with stool (acws)*[12] (0 = *not able* to 1 = *very able*).

Volitional self-efficacy. Volitional self-efficacy was measured with four items, such as 'How confident are you that you can wash hands with soap and water even if urgent tasks arise interfering with handwashing?' (0 = *not confident* to 1 = *very confident*; Cronbach's α [baseline/follow-up] = .78 /.73).

[12] During the interview respondents were informed by the interviewer that handwashing before handling food means handwashing before preparing food, eating, feeding or breastfeeding a child or handling drinking water, and that handwashing after contact with stool means handwashing after defecation, wiping a child's bottom and other contact with stool.

Impediments. Three items were used to assess impediments. People were asked, for example, ‘When you think about the last week, how often did it happen that there was no water for handwashing?’ and to specify the number of times (natural numbers used as answer scales; Cronbach’s α [baseline/follow-up] = .74/.61).

Forgetting. To measure the construct, people were asked to specify the number of times within the last 24 hours they intended to wash their hands with soap and water and then forgot to do so (natural numbers used as answer scale).

Commitment strength. Stool- and food-related commitment strengths were measured with one item each, namely, ‘Do you feel committed to wash your hands with soap and water *bhf/acws*?’ (0 = *not committed* to 1 = *very committed*).

Changes in behaviour and social-cognitive factors

To examine changes in handwashing and social-cognitive factors, baseline values were subtracted from the follow-up values for each individual. These change scores inform about the extent and direction of change but not about the absolute value in cognition or in behaviour.

Interventions and implementation design

The interventions were delivered in community meetings from October 2012 to January 2013, by one female and nine male health promoters employed and supervised by the local NGO. Twenty to thirty primary caregivers of one or several hamlets in a kebele were invited to each meeting through home visits that explained the intervention’s objective and content. The interventions were approved by the kebele leaders and elders who explicitly endorsed participation. The interventions are described in brief below; detailed descriptions can be found in the supporting information.

Interventions

Education intervention. As an education intervention, an f-diagram exercise was implemented. The f-diagram is a graph illustrating the transmission routes of diarrhoea, which is regularly used by NGOs as a hygiene behaviour change tool (e.g. David et al., 2009; Global WASH Cluster, 2011). The tool was applied as a group sorting task at a one-hour community meeting.

Public commitment intervention. Two-hour community meetings were organized where primary caregivers were asked to give oral statements of their commitment (Inauen et al., 2014). A commitment sign, a headscarf to be worn, and a commitment certificate to be pinned up were handed out.

Infrastructure-promotion intervention. Households were invited and motivated during home visits to construct a family handwashing station. Right after a one-hour community meeting which demonstrated the construction, the promoters, who also assisted in the construction, distributed jerry cans required for the handwashing station.

Intervention fidelity

To maximise intervention fidelity, all interventions were specified in detail by written instructions provided by the first author. The promoters were trained in a 2-day workshop outlined by the first author and held by supervisors of the local NGO, a local collaborator of the researchers, and representatives of a collaborating international NGO. The supervisors, supported by the local collaborator, assisted the promoters throughout the interventions and ensured the quality through field visits and by revising delivery documentation (i.e. monitoring and attendance forms). No protocol deviations were noted, with one exception. There are indications that the purpose of the public commitment sign (i.e., the scarf) was misunderstood. The researchers' main idea behind the sign was that people continuously expressed their commitment to the community by wearing the scarf, which should have constantly triggered social norms and commitment strength. Instead, it was only conveyed to the communities that the scarf served as a reminder.[13] Further, for the educ+pub arm, there is anecdotal evidence suggesting that, in some cases, the purpose of the scarf was overridden. Some respondents said that they were told to wear the scarf to be given a lift, or simply to wear the scarf when people from outside visited the kebele.

Data analysis method

The interventions' effects on change scores in behaviour through change scores in social-cognitive factors were analysed. All analyses were run separately for SRH and FRH using IBM SPSS Statistics 22, and using Bootstrapping with 10,000 re-samples for estimating confidence intervals. As directional hypotheses were tested, 90% confidence intervals were estimated. Hypotheses H1 to H8 were tested by calculating simple mediation models

[13] That the scarf would serve as a reminder was assumed to be an additional effect.

according to Hayes and Preacher (2014) and using the 'MEDIATE' macro. In each model, educ-plus combinations were represented by three dummy variables with educ-only as the reference group. For each social-cognitive factor a separate model was run, that is altogether seven models were calculated for SRH and FRH each. As these models referred to separate null hypotheses and not to a global null hypothesis, no control for the familywise error rate was necessary (Bender & Lange, 2001). All assumptions for linear regression analysis were met. Further, to investigate the combined importance of the mediators, multiple mediation models were computed using the 'INDIRECT' macro (Preacher & Hayes, 2008). Separate models were run to test for each intervention dummy variable while the other two were entered as covariates (Preacher & Hayes, 2008), that is three models were computed for SRH and FRH each. This approach was preferred to using the 'MEDIATE' macro because only the 'INDIRECT' macro provides estimates for the total and total indirect effects of the independent variable (here the educ-plus combinations). As all three dummy variables were entered in each model (one as the independent variable and the other two as covariates) their familywise error was already considered and no control for multiple testing was necessary. Again, all assumptions were met.

Results

Descriptive statistics and preliminary analyses

Descriptive statistics for handwashing and social-cognitive factors for all arms over time are presented in Table A-8 in Appendix III.

At baseline, self-reported behaviour was quite frequent and most social-cognitive factors were rather favourable. Except for volitional self-efficacy and food-related commitment strength, results from analysis of variance revealed significant between-arms baseline differences in behaviour and social-cognitive factors. As these baseline differences are not taken into account within the change scores, the mediation analyses were controlled for the baseline values. There were no differences in socio-demographic variables.

Attrition did not differ between arms and no significant differences in socio-demographics, baseline behaviour, and baseline social-cognitive factors were found between participants who were interviewed at follow-up and dropouts.

Behaviour change from baseline to follow-up was characterized by a *substantial* behaviour *decrease* in educ while behaviour increased in the educ+pub+infr, stayed constant in the educ+infr and decreased slightly in the educ+pub arm (for a detailed analysis and description, see Contzen et al., 2015).

Process of change: Mediated intervention effects

Table 29 displays the intercorrelations of changes in social-cognitive factors and in behaviour. Simple mediations revealed identical mediated intervention effects for SRH and FRH. Compared to educ, all educ-plus combinations significantly enhanced descriptive and injunctive norms, which significantly mediated the educ-plus combinations' effects on SRH and FRH (see Tables 30 and 31), supporting H1 and H2. Supporting H3 and H4 only partly, commitment strength and forgetting significantly mediated the infrastructure-promotions effects of educ+infr and educ+infr+pub on SRH and FRH, but not the effect of educ+pub. Motivational self-efficacy was enhanced by educ+infr and educ+infr+pub, and significantly mediated the infrastructure-promotions' effects on SRH and FRH, supporting H5. Volitional self-efficacy, however, was only significantly enhanced by educ+infr+pub but not by educ+infr, and it did not significantly mediate either of the infrastructure-promotions' effects on SRH and FRH. H6 was thus not supported. In line with H7, impediments were mitigated by educ+infr and educ+infr+pub, and mediated the infrastructure-promotions' effects on SRH and FRH.

Table 29. Pearson correlations between changes in SRH (below diagonal) and FRH (above diagonal) and changes in social-cognitive factors

Variables[a]	HW	DN	IN	MSE	VSE	Imped	Forget	CS
HW		0.53***	0.27***	0.18***	0.24***	-0.27***	-0.40***	0.32***
DN	0.49***		0.36***	0.13**	0.31***	-0.28***	-0.29***	0.35***
IN	0.24***	0.29***		0.11*	0.41***	-0.02	-0.08	0.31***
MSE	0.16**	0.16***	0.20***		0.10*	-0.03	-0.09*	0.32***
VSE	0.24***	0.32***	0.44***	0.12**		-0.10*	-0.13**	0.24***
Imped	-0.26***	-0.22***	-0.01	-0.05	-0.09*		0.54***	-0.20***
Forget	-0.36***	-0.29***	-0.05	-0.10[c]	-0.14**	0.54***		-0.16***
CS	0.34***	0.28***	0.25***	0.24	0.19***	-0.12**	-0.12**	

Note. N = 404. [a] Variables reflect changes in behaviour and in social-cognitive factors from baseline to follow-up. Boldface: significant with $p \leq .001$, except for the following: [b] $p \leq .01$; [c] $p \leq .05$. HW = handwashing; DN = descriptive norm; IN = injunctive norm; MSE = motivational self-efficacy; VSE = volitional self-efficacy; Imped = impediments; Forg = forgetting; CS = commitment strength.

Table 30. Simple mediation results regarding changes in stool-related handwashing: comparing intervention groups to the control group when controlling for behaviour and social-cognitive factors at baseline.

		Intervention groups											
		Educ+pub				Educ+infr				Educ+pub+infr			
			Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)		
Social-cognitive factors	b path	a path	LL	*B*	UL	a path	LL	*B*	UL	a path	LL	*B*	UL
Descriptive norm	0.49***	0.14**	**0.03**	**0.07**	**0.11**	0.16***	**0.04**	**0.08**	**0.12**	0.17***	**0.04**	**0.09**	**0.13**
Injunctive norm	0.25***	0.13**	**0.01**	**0.03**	**0.07**	0.17***	**0.01**	**0.04**	**0.08**	0.15***	**0.01**	**0.04**	**0.08**
Motivational self-eff.	0.20**	0.07*	-0.00	0.01	0.03	0.12**	**0.00**	**0.02**	**0.05**	0.11**	**0.00**	**0.02**	**0.05**
Volitional self-eff.	0.12**	-0.02	-0.02	-0.00	0.01	0.09†	-0.00	0.01	0.03	0.12**	-0.00	0.01	0.04
Impediments[b]	-0.03***	-0.50	-0.00	0.01	0.04	1.63***	**0.02**	**0.05**	**0.08**	-1.27***	**0.01**	**0.04**	**0.06**
Forgetting[b]	-0.05***	-0.35	-0.02	0.02	0.06	-1.21***	**0.03**	**0.07**	**0.11**	-0.99**	**0.01**	**0.05**	**0.10**
Commitment strength	0.42***	0.05	-0.01	0.02	0.05	0.09**	**0.01**	**0.04**	**0.07**	0.08**	**0.00**	**0.04**	**0.07**

Note. N = 403. Displayed are unstandardized coefficients. Educ = education; pub = public commitment; infr = infrastructure-promotion. b path = effects of the mediators (i.e. changes in social-cognitive factors) on changes in behaviour. a path = effects of the interventions on the mediators (i.e. changes in social-cognitive factors). CI = confidence interval; LL = lower limit; UL = upper limit. [a] Intervention groups were coded with dummy-coding using education only as the reference group. All variables were scaled from 0 to 1 (unipolar items) or from -1 to 1 (bipolar items) except for [b] that ranged from 0 to infinite. Indirect effects were calculated by bootstrapping (bold: Significant effects).† $p \leq .10$. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Table 31. Simple mediation results regarding changes in FRH: comparing intervention groups to the control group when controlling for behaviour and social-cognitive factors at baseline.

		Intervention groups[a]											
		Educ+pub				Educ+infr				Educ+pub+infr			
			Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)		
Social-cognitive factors	b path	a path	LL	*B*	UL	a path	LL	*B*	UL	a path	LL	*B*	UL
Descriptive norm	0.52***	0.12**	**0.01**	**0.06**	**0.12**	0.15***	**0.03**	**0.08**	**0.14**	0.15**	**0.02**	**0.08**	**0.13**
Injunctive norm	0.34***	0.11**	**0.01**	**0.04**	**0.08**	0.16***	**0.02**	**0.05**	**0.10**	0.12***	**0.01**	**0.04**	**0.08**
Motivational self-eff.	0.12*	0.06	-0.00	0.01	0.02	0.11*	**0.00**	**0.01**	**0.03**	0.09*	**0.00**	**0.01**	**0.03**
Volitional self-eff.	0.10**	-0.01	-0.02	-0.00	0.01	0.10†	-0.00	0.01	0.03	0.12*	-0.00	0.01	0.03
Impediments[b]	-0.03***	-0.49	-0.01	0.02	0.04	-1.63***	**0.03**	**0.05**	**0.08**	-1.29***	**0.02**	**0.04**	**0.07**
Forgetting[b]	-0.05***	-0.34	-0.02	0.02	0.06	-1.20**	**0.03**	**0.07**	**0.11**	-0.99**	**0.02**	**0.05**	**0.09**
Commitment strength	0.26***	0.05	-0.01	0.01	0.04	0.14**	**0.01**	**0.04**	**0.07**	0.12*	**0.00**	**0.03**	**0.06**

Note. N = 407. Displayed are unstandardized coefficients. Educ = education; pub = public commitment; infr = infrastructure-promotion. b path = effects of the mediators (i.e. changes in social-cognitive factors) on changes in behaviour. a path = effects of the interventions on the mediators (i.e. changes in social-cognitive factors). CI = confidence interval; LL = lower limit; UL = upper limit. [a] Intervention groups were coded with dummy-coding using education only as the reference group. All variables were scaled from 0 to 1 (unipolar items) or from -1 to 1 (bipolar items) except for [b] that ranged from 0 to infinite. Indirect effects were calculated by bootstrapping (bold: Significant effects).† $p \leq .10$. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Results from multiple mediation analysis were inspected to assess the combined importance of the assumed mediators (see Tables 32 and 33). First, a look at the total, direct and total indirect effects revealed that the social-cognitive factors mediated a large part of the total intervention effects while only one of the direct effects was significant. Second, in the multiple mediator models, only social norms, commitment and forgetting significantly mediated the interventions effects. Neither impediments nor self-efficacy did.

Discussion

This study tested the change processes of two handwashing interventions, a public commitment intervention (combining public commitment and reminder) and an infrastructure[14] promotion intervention (combining facilitating resources and reminder), in comparison to an education-only intervention in a nonrandomised controlled trial. Based on the RANAS approach (Mosler, 2012), the two interventions were developed not only theory-based but also population-tailored; that is they were matched to the critical social-cognitive factors of handwashing in the target population.

Infrastructure-promotion and education, alone and in combination with public commitment, largely predicted changes in social-cognitive factors as expected, and their effects on handwashing were mediated by these. Motivational self-efficacy, social norms, and commitment strength were enhanced while impediments and forgetting were decreased. This parallels qualitative research showing that having a handwashing station facilitates behaviour performance (Biran, 2011; Curtis et al., 2009) – which might allow mastery experience and thus increase self-efficacy – strengthens social norms (Curtis et al., 2009; Devine et al., 2012), makes water and soap easily accessible, and serves as a reminder (Devine & Koita, 2010; Scott et al., 2007). Yet surprisingly, volitional self-efficacy was not affected. A possible explanation for this may be that other impediments, such as a lack of time, which were not directly targeted by the interventions, were also crucial. In fact, one item of this self-efficacy measure referred to the difficulty of urgent tasks arising that can impede handwashing. Further qualitative research may reveal the different sources of people's volitional self-efficacy in this context.

[14] Handwashing stations

Table 32. Multiple mediation results regarding changes in stool-related handwashing: comparing intervention groups to the control group when controlling for behaviour and social-cognitive factors at baseline.

		Intervention groups											
		Educ+pub				Educ+infr				Educ+pub+infr			
			Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)		
Social-cognitive factors	b path	a path	LL	*B*	UL	a path	LL	*B*	UL	a path	LL	*B*	UL
Descriptive norm	0.36 ***	0.14**	**0.02**	**0.05**	**0.09**	0.15 ***	**0.03**	**0.05**	**0.09**	0.17 ***	**0.03**	**0.06**	**0.10**
Injunctive norm	0.05	0.14**	-0.00	0.01	0.03	0.18 ***	-0.01	0.01	0.04	0.17 ***	-0.00	0.01	0.04
Motivational self-eff.	-0.03	0.06 †	-0.02	-0.00	0.00	0.11 **	-0.02	-0.00	0.01	0.10 **	-0.02	-0.00	0.01
Volitional self-eff.	0.04	0.06	-0.01	0.00	0.01	0.08	-0.00	0.00	0.02	0.10 †	-0.00	0.00	0.02
Impediments[b]	0.00	-0.09	-0.00	0.00	0.01	-1.50 ***	-0.01	0.00	0.02	-1.08 **	-0.01	0.00	0.02
Forgetting[b]	-0.04 ***	-0.32	-0.01	0.01	0.05	-1.20 **	**0.02**	**0.05**	**0.09**	-0.99 **	**0.01**	**0.04**	**0.08**
Commitment strength	0.17 *	0.04 †	-0.00	0.01	0.04	0.10 **	**0.00**	**0.02**	**0.05**	0.09 **	**0.00**	**0.02**	**0.04**
Total indirect effects		**0.08 [0.02, 0.14]**				**0.13 [0.07, 0.20]**				**0.13 [0.07, 0.19]**			
Direct effects		0.04				0.05				0.06			
Total effects		0.12*				0.18***				0.19***			

Note. N = 403. R^2 = .61. Displayed are unstandardized coefficients. Educ = Education; pub = public commitment; infr = infrastructure-promotion. b path = effects of the mediators (i.e. changes in social-cognitive factors) on changes in behaviour. a path = effects of the interventions on the mediators (i.e. changes in social-cognitive factors). CI = confidence interval; LL = lower limit; UL = upper limit. [a] Intervention groups were coded with dummy-coding using education only as the reference group. All variables were scaled from 0 to 1 (unipolar items) or from -1 to 1 (bipolar items) except for [b] that ranged from 0 to infinite. Indirect effects were calculated by bootstrapping (bold: Significant effects).† $p \leq .10$. * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

Table 33. Multiple mediation results regarding changes in FRH: comparing intervention groups to the control group when controlling for behaviour and social-cognitive factors at baseline.

		Intervention groups[a]											
		Educ+pub				Educ+infr				Educ+pub+infr			
			Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)				Indirect effects (axb path; 90% CI)		
Social-cognitive factors	b path	a path	LL	*B*	UL	a path	LL	*B*	UL	a path	LL	*B*	UL
Descriptive norm	0.36 ***	0.11*	**0.00**	**0.04**	**0.08**	0.14 **	**0.01**	**0.05**	**0.10**	0.14 **	**0.01**	**0.05**	**0.10**
Injunctive norm	0.12 *	0.10**	**0.00**	**0.01**	**0.04**	0.15 ***	**0.00**	**0.02**	**0.05**	0.11 **	**0.00**	**0.01**	**0.04**
Motivational self-eff.	-0.04	0.04	-0.01	-0.00	0.00	0.10 *	-0.02	-0.00	0.00	0.08 †	-0.02	-0.00	0.00
Volitional self-eff.	0.02	0.00	-0.00	-0.00	0.01	0.09	-0.00	0.00	0.01	0.10 †	-0.00	0.00	0.01
Impediments[b]	-0.01	-0.39	-0.00	0.00	0.01	-1.45 ***	-0.01	0.01	0.03	-1.12 **	-0.00	0.01	0.02
Forgetting[b]	-0.04 ***	-0.32	-0.01	0.01	0.04	-1.15 **	**0.02**	**0.04**	**0.08**	-0.98 **	**0.01**	**0.04**	**0.07**
Commitment strength	0.11 **	0.08 †	-0.00	0.01	0.03	0.14 **	**0.00**	**0.02**	**0.04**	0.09 *	**0.00**	**0.01**	**0.03**
Total indirect effects		**0.08 [0.01, 0.14]**				**0.14 [0.07, 0.21]**				**0.12 [0.05, 0.19]**			
Direct effects		0.01				0.04				0.08†			
Total effects		0.09*				0.18***				0.20***			

Note. N = 403. R^2 = .65. Displayed are unstandardized coefficients. Educ = Education; pub = public commitment; infr = infrastructure-promotion. b path = effects of the mediators (i.e. changes in social-cognitive factors) on changes in behaviour. a path = effects of the interventions on the mediators (i.e. changes in social-cognitive factors). CI = confidence interval; LL = lower limit; UL = upper limit. [a] Intervention groups were coded with dummy-coding using education only as the reference group. All variables were scaled from 0 to 1 (unipolar items) or from -1 to 1 (bipolar items) except for [b] that ranged from 0 to infinite. Indirect effects were calculated by bootstrapping (bold: Significant effects).† $p \le .10$. * $p \le .05$. ** $p \le .01$. *** $p \le .001$.

In line with previous research (Kraemer & Mosler, 2012) public commitment with education enhanced social norms and mediated the educ-plus combination's effect on changes in handwashing. Contrasting previous findings (Inauen et al., 2014), however, public commitment did not increase commitment strength. One reason for this may lie in the differences of the applied interventions. Whereas Inauen et al. (2014) asked participants to read their implementation intentions to the group, simple pledging was applied in the present study. Furthermore, the expected influence of reminders (commitment sign and certificate) on forgetting was not found here. The reminding function of the commitment sign, a headscarf, might have failed because the participants seldom wore it, perhaps because they were not accustomed to it. Some have argued that reminders only unfold their effects if they are interpreted as requests (Inauen et al., 2014; Tobias, 2009), which may explain why, in general, the evidence on reminders' effectiveness in improving prospective memory is mixed (Guynn, McDaniel, & Einstein, 1998). Intervention developers should thus carefully ensure that the commitment signs are made public, and that they are interpreted as requests. Thereby, commitment and forgetting would be enhanced, and the effect of public commitment should be maximized. Particularly promising would be the use of fixed, permanently worn, or commonly used signs. Future studies should compare the effectiveness of different commitment signs and their processes of change.

In the multiple mediation models only changes in social norms, commitment and forgetting but not changes in self-efficacy and impediments mediated the interventions' effects on change in handwashing. It is credible that the former variables are more behaviour-proximal and mediated not only the interventions effects but also the influence of the latter, potentially more behaviour-distal variables.

Strengths, limitations, and perspectives

To our knowledge, this is the first study to test the underlying mechanisms of handwashing interventions. Further, it is the first application of a public commitment intervention to promote handwashing and the first quantitative test of a handwashing-station-promotion to increase domestic handwashing.

The findings in this study are also subject to some shortcomings. First, intervention allocation was not randomised. A randomised controlled trial (i.e. allocation of interventions to households) was not feasible because the interventions were public (public commitment and handwashing stations constructed at publicly visible places) so that information contamination would have been risked. Instead, interventions had to be allocated to clusters. Due to a limited number of study kebeles, it was not feasible to conduct a cluster-randomised controlled trial. Nonrandomised trials may be especially subject to cluster effects (i.e. non-comparability of intervention groups at baseline) that blur intervention effects. We tried to level this shortcoming by controlling for baseline values in behaviour and cognitions. Still, to enhance the studies internal validity, a replication applying a cluster-randomised controlled trial would be preferable.

Further, due to untimely termination of the baseline data collection, the control group sample was small. This may have decreased its power to detect significant results.

Due to feasibility issues, handwashing in this study was assessed by self-reports. These tend to be biased due to socially desirable answering tendencies or memory effects so that it is preferable to observe the behaviour instead (Biran et al., 2008; Halder et al., 2010). Nevertheless, the present results are highly relevant, because self-reported handwashing is associated with child diarrhoea, child diarrhoea mortality and cholera infection (Hutin et al., 2003; Luby, Halder, Huda, Unicomb, et al., 2011; Water Sanitation and Hygiene Research Group, 2012). Further, all participants, including those in the control arm, received an intervention and should, thus, have been equally inclined to answer in a socially desirable way. If self-reported handwashing was solely contingent on social desirability, a behaviour *increase* should have been reported in all arms. However, there were increases, decreases, and stability in self-reported handwashing. Still, the absolute handwashing rates in this study should be interpreted with caution, and future studies should aim at replicating the results by means of observational data.

Conclusions

This study revealed that theory-based population-tailored interventions were more successful in changing handwashing than a standard education intervention, because they successfully changed the critical social-cognitive factors in the target population. Moreover, the study demonstrated not only why the theory-based population-tailored interventions performed well, but also how they might be optimized. Altogether, the present study emphasizes the importance of investigating interventions' underlying change processes.

Additional information

Appendix III contains detailed interventions' descriptions and information on means and standard deviations at baseline, follow-up and changes over time by intervention group.

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Part Five

Over-reporting in handwashing self-reports: Potential explanatory factors and alternative measurements

Nadja Contzen, Sandra De Pasquale, & Hans-Joachim Mosler

Abstract

Background. The most effective prevention against diarrheal disease is handwashing with soap at key times. Handwashing interventions are thus a program priority in development and emergency relief organisations. Interventions' evaluations are essential to identify effective programs leading to improvements in behaviour and health. However, measuring handwashing behaviour is quite difficult. While household observations are considered valid, they are time-consuming and thus very cost-ineffective; self-reports are considered very efficient but are invalid (i.e. biased) due to desirable practices being over-reported. While socially desirable responding is claimed to be the main cause of the inflated self-reports, the underlying factors and mechanisms of over-reported handwashing are understudied. Therefore, the present study investigated socially desirable responding and additional factors potentially explaining the bias between self-reported and observed handwashing behaviour with the aim of gaining indications for measures mitigating over-reported handwashing. Furthermore, the project tested alternative interview questions, which were developed based on previous research, thought to alleviate the response bias.

Method. Data were collected cross-sectionally as part of a larger handwashing project in the Borena Zone, Ethiopia, by means of two- to three-hours-long observations and one-hour-long interviews with the primary caregiver in a household. A total sample of N = 554 was surveyed. Data were analysed by means of correlation analyses, multiple regression analyses, independent and dependent t-tests and analysis of variance.

Results. Over-reported handwashing was associated with factors assumed to be involved in (1) socially desirable responding (e.g. a socially desirable response style and social norms); (2) encoding and recall of information (e.g. regular daily household routine or general estimation tendency) and (3) dissonance processes (i.e. health knowledge and rationalisation). The latter two factor groups explained over-reported handwashing beyond socially desirable responding. With regard to the alternative interview questions, the tested approaches suggested in the literature to mitigate socially desirable responding (e.g. forgiving wording) did not successfully reduce over-reported handwashing. A new approach which was developed to mitigate recall errors and socially desirable responding, i.e. a script-based covert recall, reduced over-reporting when compared to conventional self-reports. However, the bias reduction emerged only on an aggregated level (i.e. mean value), while the accuracy of the measurement decreased on an individual level, probably due to increased under-reporting.

Conclusions. Although the difficulties involved in measuring handwashing by self-reports and observations are widely known, the present study is the first to investigate factors explaining over-reporting in handwashing. It also tested measures to mitigate over-reporting. While it delivers only initial results on a complex phenomenon, it contributes to a limited evidence base on a highly important subject: i.e. how to evaluate handwashing interventions efficiently and accurately. We hope that the present study stimulates further research that examines over-reported handwashing.

Keywords: Handwashing · Behaviour measure · Self-report · Observation · Over-reporting · Social desirable responding

Introduction

Diarrheal diseases and acute respiratory infections are the main causes of death in children younger than five years old globally (Black et al., 2010) and the most common causes of mortality in emergencies and disasters (Wisner & Adams, 2002). Developing countries have the highest death tolls with respect to these diseases and infections (Black et al., 2010; Watson et al., 2007). Regular handwashing with soap, especially by the primary caregiver, effectively prevents both diseases (Aiello et al., 2008; Cairncross et al., 2010a). Handwashing interventions are thus a program priority in development and emergency relief organisations (e.g. Global WASH Cluster, 2009a; United Nations Children's Fund, 2008). Interventions' evaluations are essential to identify effective programs that lead to improvements in behaviour and health; that is, evaluations are necessary to make evidence-based programming possible (Davidson et al., 2003). However, measuring handwashing behaviour can be quite difficult (Biran et al., 2008; Ram, 2013).

The standard of comparison in handwashing behaviour measurement is the structured observation in which a trained observer watches and records a household's handwashing at key times for approximately three to seven hours, ideally starting in the early morning when many critical behaviours happen, such as morning defecation, food preparation or eating (Biran et al., 2008; Ram, 2013). Even though observed behaviour tends to be affected by reactivity towards more desirable practices (e.g. Gittelsohn et al., 1997), it is rated as the most valid measure, not least because it is thought to be more objective than self-reports collected by interviews (Curtis et al., 1993; Ram, 2013). In addition, it allows the collection of individual data (e.g. data on a specific person instead of household data) and detailed information (e.g. key times, cleansing agents). On the downside, observations are rather demanding for the observer and the observed. More importantly, they are very time-consuming and thus costly; usually, a data collector can conduct only one observation a day compared to seven or more structured interviews (used for self-reports) administrable a day (Biran et al., 2008). Evaluation through observational data is especially difficult for large-scale or minimally funded projects.

Self-reported handwashing, in contrast, could be easily and very efficiently collected through interviews (Ram, 2013). However, self-reported handwashing rates tend to be inflated when compared to observed data, meaning that 'good' or 'desirable' practices are more often self-reported than they are observed (e.g. Curtis et al., 1993; Halder et al., 2010; Manun'Ebo et al., 1997; Stanton, Clemens, Aziz, & Rahman, 1987). Socially desirable responding (SDR), defined as the tendency to under-report socially undesirable behaviours and to over-report socially desirable ones (DeMaio, 1984), is thought to be the main source of bias. As a consequence, the application of self-reports to measure handwashing practice has been advised against (e.g. Biran et al., 2008; Ram, 2013).[15]

In sum, observations are thought to be valid but very cost-ineffective, while self-reports are thought to be very cost-effective but invalid, thus making the measurement of handwashing practice needed to evaluate handwashing interventions a big challenge (Biran et al., 2008; Curtis et al., 1993; Ram, 2013). Interestingly, although SDR is claimed to be the main cause of these inflated self-reports, to our knowledge, only one study tested the influence of SDR on self-reported hygiene and handwashing behaviour (Stevenson et al., 2009). Furthermore, this study only investigated SDR as a respondent's personality characteristic but not as a characteristic of a questionnaire's topic or of the situation in which a questionnaire is administrated (see below for more details). To our knowledge, no alternative sources of the inflated self-reported handwashing rates have ever been tested. A better understanding of the causes and underlying mechanisms of over-reported handwashing, however, might indicate measures to mitigate over-reporting, including improved interview questions that constitute an efficient and valid self-report measure of handwashing. Therefore, the main aim of the present study was to investigate SDR and additional factors potentially explaining the bias between self-reported and observed handwashing behaviour. The corresponding research questions were whether SDR and additional factors are associated with over-reported handwashing and whether additional factors explain over-reporting beyond SDR. In addition, we investigated whether alternative self-report measures, thought to reduce the influence of SDR and additional factors, mitigate the response bias.

As to the underlying mechanisms of over-reporting, the present paper considers the following three components[16] that are thought to be involved in the process of responding to a survey question and which may bias responses (Tourangeau & Yan, 2007):

(1) Questions are usually answered based on relevant information existing in memory, which implies that the information had to be encoded before. However, the encoded and stored

[15] As an alternative, efficient measure of handwashing, proxy measures or spot checks (e.g. observed presence of soap or water) have been tested (e.g. Biran et al., 2008; Luby, Halder, Huda, Unicomb, et al., 2011; Luby, Halder, et al., 2009). While their performance is not always satisfying (e.g. Biran et al., 2008), a major disadvantage of most spot checks is that they do not provide individual data but only household data. To evaluate the effectiveness of interventions, however, behaviour change in an individual, targeted person is often of interest.

[16] In addition, a question also has to be understood. Although this component may also cause response biases, it was not considered in the present study.

information might have been inaccurate in the first place (e.g. 100% handwashing compliance is encoded even though compliance is actually only around 50%). As a consequence, already biased information is retrieved and reported (Tourangeau & Yan, 2007). The accuracy of the encoded information might be affected by the regularity of one's daily household routine and the frequency with which one is interrupted during this routine.

(2) The question-relevant information existing in memory has to be recalled. However, the information might be inaccurately retrieved from memory (e.g. not all instances of handwashing neglect are retrieved) and/or the information might be integrated by means of an inappropriate estimation or judgment strategy (e.g. "I eat five times a day and so I wash my hands five times a day"; Tourangeau & Yan, 2007). While the abovementioned factors (i.e. regular daily routines and frequency of task interruptions) might also affect information recall, people might also differ in their general estimation tendency.

(3) Finally, the response has to be reported. However, even when a correct response is found, it might be distortedly reported or edited (e.g. a higher handwashing frequency is reported than was found). The most frequently studied form of response editing is SDR, which is the same factor primarily thought to underlie over-reported handwashing (DeMaio, 1984; Schwarz & Oyserman, 2001).

In addition to these general processes involved in responding, a factor is considered in the present paper which might also be involved in encoding inaccuracy, i.e. *cognitive dissonance,* a state of psychological tension arising when a person's cognitions (e.g. the knowledge that handwashing prevents diarrhoea) and behaviour (e.g. low frequency in handwashing) are inconsistent (Festinger, 1962). Over-reporting might result from the attempt to dissolve this feeling of tension by increasing the perceived and thus encoded frequency in handwashing.

In the following, we discuss SDR as a potential cause of over-reported handwashing before examining the additional processes and factors potentially resulting in over-reported handwashing.

Response editing: Social desirability as a source of response bias

SDR has long been recognized as a major cause of response bias in questionnaire research, including the field of health behaviour research (Edwards, 1957; see also DeMaio, 1984; Kristiansen & Harding, 1984; U.S. Department of Health Education and Welfare, 1977); see also (DeMaio, 1984)). It has been investigated as a personality characteristic, a theme or item characteristic and as depending on situational characteristics (DeMaio, 1984; Donaldson & Grant-Vallone, 2002; Edwards, 1957). These different conceptualisations of SDR will be discussed further below.

Social desirability as a personality characteristic or personal response style

Individuals vary in their tendency to respond in a socially desirable manner (e.g. Crowne & Marlowe, 1960; Paulhus, 1984). Using the most popular scale to measure individual differences in SDR, i.e. the Marlow-Crown-Social-Desirability Scale (MCSDS; Crowne & Marlowe, 1960), a small but significant positive association was found between a socially desirable response style and self-reported hygiene and handwashing (Stevenson et al., 2009). Stronger associations were found with a more general preventive health behaviour score that included behaviours such as sharing unwashed glasses, drinking and driving or washing hands after using the toilet (Kristiansen & Harding, 1984). In line with these findings, the first hypothesis was as follows:

> H1: The higher the tendency to respond in a socially desirable manner is (e.g. high MCSDS scores), the higher the over-reporting in self-reported handwashing will be.

The primary mechanism thought to underlie a socially desirable response style is a need to conform to social standards or a need for approval (Crowne & Marlowe, 1960; DeMaio, 1984). Conforming to social standards helps to ensure membership in a social group (Curtis et al., 2009), which satisfies a fundamental need to belong, initially developed to secure survival and reproduction (Baumeister & Leary, 1995). Conforming to social standards should be especially high when people feel strongly attached to their social in-group (Turner, Hogg, Oakes, Reicher, & Wetherell, 1987). Accordingly, we hypothesised as follows:

> H2: The higher the need for conformity is, the higher the over-reporting in self-reported handwashing will be.
>
> H3: The higher the feeling of group attachment is, the higher the over-reporting in self-reported handwashing will be.

Social desirability as a theme or item characteristic

In addition to varying between individuals, SDR also depends on the nature of the questionnaire topic; some are rather neutral (e.g. to share unwashed glasses) while others are sensitive, meaning they are highly socially desirable or undesirable (e.g. to wash hands after using the toilet or to drink and drive; Edwards, 1957; Tourangeau & Yan, 2007). Sensitivity depends on whether a clear social norm exists regarding the behaviour or attitude at hand (Tourangeau & Yan, 2007). In other words, when a social norm prescribes certain behaviour (i.e. handwashing) and is perceived as such, self-reported behaviour will be biased towards the perceived social norm. Critical for SDR is not the 'actual' social norm but the individually perceived social norm, meaning that the degree of a question's sensitivity can differ between respondents (Näher & Krumpal, 2012; Tourangeau & Yan, 2007). A question's perceived sensitivity influences responding more heavily than individual response styles (Phillips & Clancy, 1972; Randall & Fernandes, 1991; Tourangeau & Yan, 2007). In the literature, descriptive and injunctive norms have been distinguished, with the former referring to what most others are doing and the latter reflecting the expected social approval or disapproval of a behaviour (Cialdini et al., 2006). In previous research descriptive norms were found to explain SDR (Näher & Krumpal, 2012). We assumed the following:

> H4 and H5: The stronger the perceived descriptive and injunctive norms that favour handwashing are, the higher the over-reporting in self-reported handwashing will be.[17]

Social desirability as a situational characteristic

Given that a question is sensitive, the level of privacy or confidentiality during the interview impacts SDR (Brener, Billy, & Grady, 2003; Tourangeau & Yan, 2007).[18] Third parties may be present, such as the spouse, family members or neighbours. Whether and how the presence of a third party influences the responses is thought to depend on the following two factors: first, the third party's prior knowledge about the requested information inasmuch as prior knowledge makes it more difficult to respond in a socially desirable manner and thus evokes more honest responses; and second, the degree to which any consequences of revealing the information to the third party are feared, meaning that SDR is evoked only when negative consequences are anticipated (Aquilino, 1997; see also Tourangeau & Yan, 2007; Aquilino,

[17] It should be mentioned that social norms are thought to be a key determinant of behaviour (e.g. Fishbein & Ajzen, 2010). Accordingly, social norms are also expected to be associated with actual handwashing behaviour.
[18] SDR is lowest in self-administered questionnaires (Brener et al., 2003; Tourangeau & Yan, 2007). However, in developing countries, where illiteracy rates are high, these are often not feasible (Bulmer & Warwick, 1993).

Wright, & Supple, 2000). Prior knowledge and perceived consequences might differ regarding a spouse or neighbours. Accordingly, the present study investigated the following:

Q1: Is the presence of the spouse during the interview associated with over-reporting in self-reported handwashing?

Q2: Is the presence of other adults during the interview associated with over-reporting in self-reported handwashing?

Inaccurate memory formation as a source of response bias

When respondents report their frequency in handwashing, they draw upon the information stored in their memory. However, the encoded frequency information might have been incorrect. A factor potentially affecting the encoded information is forgetting to perform handwashing. Forgetting might cause inaccuracy because when people forgot to wash their hands they may not notice that they forgot. For other health behaviours (e.g. water treatment), forgetting is often traceable and becomes evident rather quickly and easily. For example, if water filtering is forgotten, there is eventually an absence of filtered water, and forgetting is detected. However, forgetting to wash one's hands at a certain moment may never become salient. This means that respondents may not realize how often they intended to wash hands but forgot; therefore the encoded handwashing frequency may be biased from the actual amount towards the intended amount. Thus, it can be concluded that the more handwashing is forgotten, the higher the over-reporting should be in self-reported handwashing. The following two factors were assumed to affect forgetting: the regularity of daily routines and the frequency of task interruptions.

First, it is credible that behaviour is more easily remembered and thus more accurately performed when it is intended to be performed at regular times during a given day. Handwashing itself is not a regular behaviour happening at a regular time of day (e.g. at 2pm) or on a specific day (e.g. every Friday). However, it mostly happens contingent on key times (e.g. after defecation, before preparing food or feeding the child) which may follow a certain regular daily routine. A regular daily routine may thus help people to remember the intention to wash hands, that is, to mitigate forgetting (which is not equivalent to actually performing the behaviour). This may lead to more accurate encoding (either because the actual handwashing frequency is more congruent with the intended frequency or because people are more aware of not having followed their good intentions) which would result in more accurate handwashing reports. Therefore, we hypothesised as follows:

> H6: A regular daily household routine is associated with less over-reporting in self-reported handwashing than an irregular daily household routine.

Second, even with a daily routine, behaviour performance (including that of key behaviours or key times, which should be accompanied by handwashing) may be interrupted by another task, person or event needing attention. Dealing with many things at once impairs remembering (Gollwitzer & Sheeran, 2006), so that people might forget regular handwashing more often when they are frequently interrupted during behaviour performance. Moreover, people might forget to re-wash their hands when resuming a key behaviour (e.g. food preparation) after having been interrupted. All in all, frequent task interruptions or pressure to multitask might increase unnoticed forgetting. Correspondingly (and giving some support to our reasoning), there is some evidence that mothers are consciously neglecting handwashing at key times due to high task load or due to the need to react quickly (e.g. because the baby is crying and needs to be pacified; Affleck & Pelto, 2012). Frequent task interruptions might cause more unnoticed forgetting and thus encoding of an inaccurate handwashing frequency which ultimately leads to over-reporting. In sum, we hypothesised the following:

> H7: The more frequently tasks are interrupted, the higher the over-reporting in self-reported handwashing will be.

Recall errors

When information is retrieved and integrated in order to respond to a question, over-reporting may also be caused. The ideal scenario for accurate responses would be that the respondent scans the memory, retrieves all relevant instances and counts them to determine an overall frequency (Menon & Yorkston, 2000; Schwarz & Oyserman, 2001). However, such a recall-and-count or enumeration strategy is limited to rare, important or emotionally arousing behaviours with high salience that sunk deep into the individual’s memory (Schwarz & Oyserman, 2001; Tourangeau, 2000). Handwashing is a frequent, mundane and unemotional behaviour with low salience which will rarely be stored in memory as a single instance. More importantly, such behaviours are stored as one global, knowledge-like representation (Schwarz & Oyserman, 2001) or script (i.e. the expected sequence for frequently experienced events or activities; Weisberg, 2005).[19] For these, frequency assessments are usually based on some estimation strategy (Menon & Yorkston, 2000; Schwarz & Oyserman, 2001). However,

[19] As an upside, because such behaviours are stored as scripts, recall errors due to memory that decrease over time are less an issue than for rare, important events stored as single instances (Schwarz & Oyserman, 2001).

when compared to enumeration strategies, estimation strategies were found to result in over-reporting (N. R. Brown, 2002; Burton & Blair, 1991); this might contribute to over-reports in handwashing. While all respondents are thought to be affected by this, there might be individual differences in recall error.

First, people usually differ with regard to their memory performance with some people performing better than others in a variety of memory tasks (Loftus, Levidow, & Duensing, 1992; Unsworth & Engle, 2007). It is plausible that people differ in their capacity to estimate frequencies with some people generally over-estimating, some being rather accurate and others generally under-estimating. Accordingly, we hypothesised as follows:

> H8: The more a person generally tends to over-estimate, the higher over-reporting in self-reported handwashing will be.

Second, frequent behaviours are often assessed by rate-based estimation strategies (e.g. I eat three times a day; that makes 21 times a week) which produce fairly accurate estimates when behaviour is regular but rather inaccurate estimates when behaviour is irregular (i.e. when exceptions to the usual behaviour are numerous; Burton & Blair, 1991; Menon & Yorkston, 2000; Schwarz, 1990). More precisely, there is evidence that *irregular* frequent behaviours tend to be over-reported compared to *regular* frequent behaviours (e.g. Menon, 1993). Accordingly, a regular daily routine may not only improve encoding but could also help in recalling the handwashing-relevant information in order to provide more accurate frequency estimates, which further underpins hypothesis 6 above. Frequent task interruptions, on the other hand, might counteract such a reporting-enhancing influence of a daily routine, because a rate-based estimation fails under this condition (see hypothesis 7 above).

Cognitive dissonance as a source of response bias

A further factor which might increase encoding inaccuracy and thus over-reporting is cognitive dissonance. According to the dissonance theory (Festinger, 1962, 1968), people suffer a state of psychological tension when their cognitions (e.g. knowledge or attitudes) and/or behaviour are inconsistent (Festinger, 1962). People try to dissolve the tension by changing the behaviour or related cognitions. With regard to handwashing, people might suffer an uncomfortable feeling if they knew about the preventive effects of handwashing at key times but were not always doing so. To reduce discomfort without changing the behaviour[20], they could rationalise the behaviour neglect by changing cognitions (e.g. blank out the relevant health knowledge), decreasing their importance (e.g. downplay the importance of handwashing or the severity of diarrheal disease), adding consonant cognitions (e.g. 'frequent handwashing irritates the skin') or increasing the importance of existing consonant information (e.g. 'water is needed for other, more important things than handwashing'; for a recent study of rationalisation in smokers, see Fotuhi et al., 2013). Alternatively, one could also change the cognitive representation of the behaviour (Festinger, 1962). While Festinger (1962) assumes that the behavioural cognitive element mirrors the actual behaviour, it is credible that the behavioural cognitive element is similarly flexible as the attitudinal or knowledge-related cognitive elements. That is, a person might reduce dissonance by changing the perceived and thus encoded frequency of behaviour (see also Näher & Krumpal, 2012; Tagliacozzo, 1979). A reporting bias would thus result because inaccurate behaviour information was encoded. In line with this reasoning, a previous study found that heavy smokers (between one and two packages a day) that were more aware of the negative health consequences of smoking (i.e. assumed dissonance) self-categorized themselves as moderate smokers (i.e. underreporting), while those that were less aware of the negative consequences of smoking (i.e. assumed consonance) self-categorized themselves as heavy smokers (accurate reporting; Tagliacozzo, 1979). Translated to handwashing, over-reports in self-reported handwashing might reflect a person's attempt to reduce the experienced dissonance due to accurate health knowledge and a neglect of health behaviour by increasing the perceived and thus encoded frequency in handwashing. To summarise, people with insufficient handwashing compliance but accurate health knowledge were expected to reduce the discomfort felt due to dissonance 1) by cognitively rationalising the neglect of handwashing or 2) by increasing the perceived handwashing frequency, that is, by over-reporting. Accordingly, we hypothesized as follows for people with imperfect handwashing compliance:

> H9: The higher the handwashing related health knowledge is, the higher the over-reporting in self-reported handwashing will be.
>
> H10: The higher the cognitive rationalisation of neglected handwashing is, the lower the over-reporting in self-reported handwashing will be.

[20] Sometimes, adopting uninterrupted handwashing may be infeasible (e.g. lack of water), burdensome or unattractive (e.g. long distances to walk to the next handwashing facility, interference with other tasks).

> H11: Health knowledge and rationalisation interact with the highest over-reporting found for high health knowledge and low rationalisation and with the lowest over-reporting found for low health knowledge and high rationalisation.

In contrast to SDR, which partly depends on the situation in which a question is answered (see above), dissonance-induced over-reporting can be expected to be independent of situational characteristics because the over-reports represent a person's genuine behavioural cognitive element. This might also be of interest for handwashing interventions which could actively exploit the dissonance processes (see Discussion).

Potential methods to mitigate over-reported handwashing

When factors were found that largely explain a reporting bias, several approaches were possible to mitigate their influence on response bias in intervention evaluations. First, the factors' influence could be statistically controlled for (e.g. social desirable response style or general tendency to overestimate; see discussion for more details; King & Bruner, 2000; Paulhus, 1991). Second, the influence of SDR could be mitigated by optimizing the interview situation, namely the perceived privacy (see discussion for more details; Tourangeau & Yan, 2007). Third, interview questions could be improved (Tourangeau & Yan, 2007). In the following, this third option is discussed in more detail with regard to sensitive questions and recall errors.

Alternative self-report measures to mitigate question sensitivity

To reduce the effects of question sensitivity it was suggested to vary the wording of the questions or the context of the question so as to encourage honest, potentially embarrassing responses (Tourangeau & Yan, 2007). A first approach suggests 'loading' the question's wording by presupposing the neglect of a desired behaviour (e.g. instead of asking about washing hands, ask about *not* washing hands) or the engagement in an undesired behaviour (Tourangeau & Yan, 2007; Weisberg, 2005). Alternatively, 'forgiving wording' could be applied, that is, introducing a sensitive question with a reasonable excuse for the neglect of a desired behaviour (e.g. there is not enough time or water for handwashing; Näher & Krumpal, 2012; Tourangeau & Yan, 2007; Weisberg, 2005). Similarly, it has been suggested to embed a sensitive question in a permissive context, namely to precede the question with a statement that opposes the desired behaviour (e.g. regular handwashing uses up too much water); a restrictive context on the other hand, that is, a statement supporting the desired behaviour (e.g. caring mothers wash hands regularly), is expected to increase the effects of question sensitivity (Näher & Krumpal, 2012; Tourangeau & Smith, 1996). Only a few studies have tested the ability of these techniques to mitigate SDR, the majority of which did not successfully prevent SDR (for an overview, see Tourangeau & Yan, 2007). Nevertheless, we tested these approaches and expected the following:

> H12-1: Loaded question wording causes lower self-reported handwashing than unloaded question wording.
>
> H12-2: Forgiving wording with loaded question wording causes lower self-reported handwashing than loaded question wording alone.
>
> H12-3: A permissive context with loaded question wording causes lower self-reported handwashing than loaded question wording alone.
>
> H12-4: A restrictive context with loaded question wording causes higher self-reported handwashing than loaded question wording alone.

Alternative self-report measures to mitigate recall errors

First, in order to mitigate recall errors of frequency reports, it was suggested to ask open-ended instead of closed questions (Schwarz & Oyserman, 2001). When applying an estimation instead of an enumeration strategy (which is typically the case for frequent, mundane behaviours such as handwashing), respondents tend to use all information available to estimate the frequency, including answer categories (Schwarz & Hippler, 1991). That is, respondents assume that the response alternatives of closed questions reflect the behaviour distribution in the population with the fringe categories representing extreme behaviour and the middle category representing average or typical behaviour; respondents tend to estimate their own frequencies according to this frame of reference and thereby to distort their estimates (Schwarz & Hippler, 1991). For example, when presented with answer categories reflecting a high range ('up to 2.5' to 'more than 4.5') in contrast to a low range ('up to 0.5' to 'more than 2.5'), higher frequencies are reported. Frequency of handwashing is often measured by open-ended questions (e.g. Water Sanitation and Hygiene Research Group, 2012). The difficulty regarding handwashing, however, is that we are not only interested in the overall frequency (e.g. handwashing 20 times a day). We are much more interested in the ratio of times that hands were washed compared to times that such washing was omitted.[21] Accordingly, one would have to separately assess the frequency of key behaviours during a

[21] For example, that one person washes her/his hands at 20 key times a day while another washes her/his hands only at 16 key times a day does not mean that the first person more accurately follows some handwashing recommendations; it may also reflect that the first person is engaged in more key behaviours than the latter person.

day and the frequency of handwashing at key times during a day before then calculating their ratio. The application of two separate frequency estimates, however, might result in rather inaccurate ratios because the separate estimates might both be affected by the discussed problems involved in frequency estimations. Alternatively, respondents could be presented with questions and answer categories that explicitly reflect the ratio between handwashing and key times (e.g. ‘How often do you wash your hands before preparing food?’) with the following answer categories: ‘in less than 20% of the cases’, ‘in 20% to 40% of the cases’, ‘in 41% to 60% of the cases’, ‘in 61% to 80% of the cases’ and ‘in more than 80% of the cases’. Because such an answer scale ranges from 0% to 100%, the probability that it is misinterpreted to reflect the population’s behaviour distribution is rather low.

Another strategy that was suggested to mitigate recall errors is to provide additional memory cues to facilitate information retrieval (e.g. the location of the relevant behaviour; Schwarz & Oyserman, 2001; Weisberg, 2005). However, additional memory cues only increase the accuracy of frequency estimates of infrequent, irregular and distinct events[22] and do not increase the accuracy of frequency estimates of mundane, frequently repeated events such as handwashing (Burton & Blair, 1991; Weisberg, 2005). Cues may even reduce the accuracy in estimating frequencies of regular events because they induce the use of an enumeration strategy, which is thought to be suboptimal for frequent events (Burton & Blair, 1991; Schwarz, 1990). Also, a specific method to provide additional cues – the decomposition of a class of events (e.g. drinking alcohol) down into subclasses (e.g. drinking wine, drinking beer, drinking liquor) – was found to increase *over*estimation of globally frequent events, such as handwashing behaviour (Schwarz & Oyserman, 2001). Still, with regard to handwashing, it may often be necessary to assess it in decomposed subclasses (i.e. handwashing at key times), because from a health perspective the frequencies at key times, not the general handwashing frequency, is of interest (Luby, Halder, Huda, & Johnston, 2011).

It was also suggested to use cues that remind the respondents about event sequences or activity sequences (e.g. food preparation) instead of a specific, critical event or action (e.g. handwashing; Bradburn, 2000; Reiser, Black, & Abelson, 1985). Others suggested to ask respondents to reconstruct the whole process leading to the behaviour of interest instead of asking directly about the behaviour (Weisberg, 2005). Accordingly, for the present case of handwashing, instead of asking respondents about the critical action (i.e. handwashing), one could ask them to recount typical behaviour sequences of key activities (e.g. food preparation

[22] They also help remember specific events in more detail (Burton & Blair, 1991; Weisberg, 2005).

after returning from the market or after feeding the animals). In doing so, the corresponding behavioural scripts, in which the relevant information about how one generally performs the key activities is stored, should be activated.[23] It is credible that for those respondents who regularly wash their hands before or after a specific key activity, handwashing is an integral part of the respective script. Accordingly, these respondents should mention handwashing unprompted when retelling their typical behaviour sequences. In addition, if respondents were not explicitly asked about handwashing (covert recall) and were thus not aware of the questions' purpose and potential sensitivity of their content, SDR might also be mitigated. Therefore, we hypothesised as follows:

> H13: A script-based covert recall produces smaller over-reporting than an action-based prompted recall (i.e. a 'standard' self-report measure).

To sum up, the present study investigated whether SDR, inaccuracies in encoding, recall errors and dissonance processes are associated with over-reported handwashing and whether the latter processes explain over-reporting beyond SDR. Furthermore, we tested whether alternative self-report measures, expected to mitigate SDR and recall errors, reduce over-reported handwashing. Table 34 summarises the outlined hypotheses and research questions. In order to test these hypotheses and research questions, a cross-sectional study was conducted in Ethiopia that combined observational and self-reported data.

[23] It should be emphasized that the targeted scripts are the ones for performing the key activities (e.g. food preparation) and not the ones for performing handwashing at key times. The scripts which were mentioned earlier as being potentially biased due to encoding distortions are thought to be the scripts for handwashing at key times and not the ones for key activities.

Table 34. Overview of the hypotheses and research questions regarding

General process	Hypotheses and research questions	
Factors associated with OvR [a]		
SDR	H1	The higher the tendency to respond in a socially desirable manner is (e.g. high MCSDS scores), the higher OvR in SRHW[b] will be.
	H2	The higher the need for conformity is, the higher OvR in SRHW will be.
	H3	The higher the feeling of group attachment is, the higher OvR in SRHW will be.
	H4	The stronger the perceived descriptive norm that favours handwashing is, the higher OvR in SRHW will be.
	H5	The stronger the perceived injunctive norm that favours handwashing is, the higher OvR in SRHW will be.
	Q1	Is the presence of the spouse during the interview associated with OvR in SRHW?
	Q2	Is the presence of other adults during the interview associated with OvR in SRHW?
Encoding/Recall	H6	A regular daily household routine is associated with less OvR in SRHW than an irregular daily household routine.
	H7	The more frequently tasks are interrupted, the higher OvR in SRHW will be.
Recall	H8	The more a person generally tends to over-estimate, the higher OvR in SRHW will be.
Dissonance	H9	For persons with imperfect handwashing compliance holds: The higher the handwashing related health knowledge is, the higher OvR in SRHW will be.
	H10	For persons with imperfect handwashing compliance holds: The higher the cognitive rationalisation of neglected handwashing is, the lower OvR in SRHW will be.
	H11	For persons with imperfect handwashing compliance holds: Health knowledge and rationalisation interact with the highest OvR found for high health knowledge and low rationalisation and with the lowest OvR found for low health knowledge and high rationalisation.
Alternative interview questions to mitigate OvR		
SDR	H12-1	Loaded question wording causes lower SRHW than standard self-reports.
	H12-2	Forgiving wording with loaded question wording causes lower SRHW than loaded question wording alone.
	H12-3	A permissive context with loaded question wording causes lower SRHW than loaded question wording alone.
	H12-4	A restrictive context with loaded question wording causes higher SRHW than loaded question wording alone.
Recall/SDR	H13	A script-based covert recall produces smaller OvR in SRHW than an action-based prompted recall.

Note. [a] OvR = Over-reporting. [b] SRHW = Self-reported handwashing.

Methods

Research area and participants

The study was conducted as part of a larger research project investigating handwashing in four Borena kebeles (smallest administrative units of Ethiopia, similar to wards) in southern Ethiopia. The Borena Zone is a semi-arid region recurrently hit by droughts. Governmental and non-governmental organisations have implemented handwashing interventions in the Borena Zone since 2006 as part of their drought responses.

Each of the four study kebeles consisted of around 30 hamlets; only those that were reachable by car or a maximum 20-minute walk were included in the study. Within a hamlet, households were randomly selected by the random-route method (Hoffmeyer-Zlotnik, 2003). The eligibility criterion for participation, which was assessed by self-report, was being a primary caregiver (usually a woman) of children younger than five years of age. They were targeted since they are responsible for childcare and cooking and thus have the highest impact on transmitting diarrhoea to the children.

Sample size estimation with G*Power 3.1 (Faul et al., 2009a) suggested to survey 300 households to detect a small to medium effect at the Type I error probability of 0.05 and a statistical power of 0.95. It was unlikely that in each study household all relevant behaviours (e.g. primary caregiver's defecation) would occur during observation sessions; therefore, to ensure an adequate sample size for the observations of each relevant behaviour, the study aimed to survey 500 randomly selected primary caregivers of children under the age of five. Eventually, 554 primary caregivers were surveyed. Still, the observed data sample sizes were rather small for some key times (e.g. n = 71 for the key time 'wiping a child's bottom').

All respondents were women; most were married (n = 501, 90.4%) and were mothers of a child younger than five years in the household (n = 471, 85.2%). Their mean age was 34.25 years (SD = 13.76). The vast majority of the respondents had never attended school (n = 535, 96.6%) and were illiterate (n = 542, 98.2%). On average, study households comprised one child younger than five years (M = 1.35, SD = 1.05). The mean income per person, per day was US \$0.20 (SD = 0.21), which was far below the poverty line of US \$1.25 (Ravallion et al., 2009).

Research designs

The present study was interested in factors associated with over-reported handwashing and measures to mitigate it. This implied a comparison between observed and self-reported data, and thus in order to maximise comparability a cross-sectional design measuring all variables at one point in time seemed most appropriate. A correlational design was applied to investigate factors associated with over-reporting (H1–H11, Q1–Q2) and the script-based covert handwashing recall (H13). To test alternative self-report measures expected to mitigate SDR (H12-1–H12-4), an experimental design was applied by using four different questionnaire versions which were randomly assigned to the participants.

Data collection procedure

Data collection took place in February and March 2013 and included two-and-a-half-hours-long observations and one-hour-long interviews. Observations took place at dawn or around noon during lunch preparation and were followed by the interviews. Data were collected by 14 local students and social workers, of which two were female and 12 were male. To ensure high quality in the data collection, the team was extensively trained in interviewing techniques and the observation procedure during a four-day workshop. They were also supervised during data collection by the first author, a local research collaborator and a postgraduate student.

Ethics statement

This study was conducted in strict compliance with the ethical principles of the American Psychological Association (APA) and the Declaration of Helsinki. It was part of a larger research project on handwashing which received favourable ethical approval from the Ethiopian National Research Ethics Review committee and the Ethics Committee of the Philosophical Faculty of University of Zurich. As approved by the above ethics boards, oral informed consent was obtained from all study participants. Written consent could not be obtained due to the high illiteracy rate in the sample (see above). Whenever a selected household refused to participate in the study, the household was thanked and the research team members left immediately. The number of refusing households was marked in a dedicated space in the questionnaire of the next consenting household.

Measures

The interviews were based on a structured questionnaire developed for this study. The items covered self-reported handwashing (standard measure), potential explanatory factors, alternative self-report measures of handwashing and socio-demographic characteristics. Most of the response options were Likert scales (5-point scales for unipolar items and 9-point scales for bipolar items), which were transformed into a value range of 0–1 (or −1 to 1 for bipolar items) to facilitate interpretation. The questionnaire was prepared in English, translated into Afan Oromo and then retranslated into English to ensure the quality of the translation. A structured format was prepared for observations (Iyer et al., 2005). The applicability of the questionnaire and the observation format was verified in a pre-test of $N = 28$.

Self-reported handwashing (standard measure)

Self-reported handwashing was measured by nine items in the following format: 'In general, how often do you wash your hands with soap *before eating*/*after defecation*?' (0 = *almost never/0–1 out of 10 times* to 1 = *almost always/9–10 out of 10 times*)[24] (Contzen & Mosler, 2013). The surveyed key times were those usually promoted in handwashing interventions focusing on diarrhoea prevention (Luby, Halder, Huda, & Johnston, 2011), that is, after defecation (and urination)[25], after wiping a child's bottom or after other contact with stool (stool-related handwashing, SRH); as well as before preparing food or handling drinking water, before feeding or breastfeeding a child and before eating (food-related handwashing, FRH). Previous research found that SRH and FRH are separable and partly explained by different social-cognitive factors (Contzen & Mosler, 2013). This was confirmed in the present study by confirmatory factor analysis. Internal consistency was satisfactory (Cronbach's α SRH = .90, Cronbach's α FRH = .90). As it was assumed that over-reporting and its causing factors might differ for different key times, most analyses were run separately for SRH and FRH. Separate analyses for each key time were not feasible as sample sizes per key time were often too small with regard to observational data. In order to compare these standard self-report measures to loaded question wording, which did not ask for separate key times, SRH and FRH were averaged.

[24] Using percentages as suggested in the Introduction was not feasible as respondents did not share the relational concept of percentages. Instead, their relational concept is based on comparisons with the reference value of '10', which was accordingly applied in the present project.

[25] During observations, it was apparent when a caregiver went to defecate or urinate as they left the compound and squatted behind a nearby bush. However, it was not possible to distinguish between defecation and urination. To keep self-reported and observed data comparable, we therefore asked not only about handwashing after defecation but also about handwashing after urination.

Observed handwashing

The same key times as those measured by self-reports were observed. In case a key event occurred, it was noted in a structured format along with the information regarding whether both hands were washed with water before or after the event and whether soap was used. During data processing, observed handwashing was calculated for each respondent and for each type of key event separately (e.g. food preparation) as the percentage of times both hands were washed with soap out of all the times handwashing would have been necessary (e.g. food was prepared). To allow for direct comparison with the self-reports, observational data concerning faces or food were averaged to form observed SRH and FRH, although internal consistency was rather low (Cronbach's α stool = .46; Cronbach's α food = .56). However, these estimates were based on very small samples (n_{stool} = 24 and n_{food} = 17) as only a few participants were observed at all respective key times; that is, internal consistency could not be conclusively assessed. Response scales ranged from 0 = *0% handwashing* to 1 = *100% handwashing.*

Over-reports in self-reported SRH and FRH

To examine over-reporting in self-reported handwashing, observed values were subtracted from the self-report values for each individual and separately for SRH and FRH; the same was done for each key time separately. Response scales ranged from -1 = *100% underreporting* over 0 = accurate reporting to 1 = *100% over-reporting.*

Factors potentially involved in socially desirable responding

Socially desirable answering as a personality characteristic. A social desirable response style was assessed by the short form C (Reynolds, 1982) of the MCSDS (Crowne & Marlowe, 1960). A previous study verified the MCSDS's applicability in Ethiopia (Vu, Tran, Pham, & Ahmed, 2011); the short form was successfully applied in other African countries (Verardi et al., 2010). The full scale contains 33 items and the short form contains 13 items of culturally acceptable and approved behaviours which are, at the same time, relatively unlikely to occur (Crowne & Marlowe, 1960), such as 'No matter who I'm talking to, I'm always a good listener' (0 = false; 1 = true). With regard to social desirability, the items are keyed true and false in order to preclude the influence of acquiescence tendency. In order to ensure that all responses were keyed in the format 0 = no socially desirable answering and 1 = socially desirable answering, during data processing eight items were recoded. Although internal consistency was low (Cronbach's α = .50), items were averaged according to the original short form C (Reynolds, 1982).

Need for conformity. This was assessed with one item, that is, ‘In general, do you want to do what people who are important to you think you should do?’ (0 = *not at all* to 1 = *very much*) (Ajzen, 1991).

Group attachment. One item was applied that read ‘Do you feel a sense of belonging when you are with members of your community?’ (0 = *no sense of belonging* to 1 = *a strong sense of belonging*) (Crisp, Walsh, & Hewstone, 2006).

Descriptive norm. Two items were applied for both SRH and FRH, such as ‘How many people of your community wash hands with water and soap *before handling food/after contact with faeces*?’ (0 = *almost nobody* to 1 = *almost all of them*; Cronbach’s α stool =.75; Cronbach’s α food =.79) (Contzen & Mosler, 2013).

Injunctive norm. Stool- and food-related injunctive norms were measured with two items each. Respondents were asked, for example, ‘Do people who are important to you think that you should or should not wash your hands with soap and water *before handling food/after contact with faeces?*’ (-1 = *nearly all think I should not* to 1 = *nearly all think I should*; Cronbach’s α stool =.55; Cronbach’s α food =.60) (Contzen & Mosler, 2013).

Presence of spouse or other adults. Directly before assessing self-reported handwashing the interviewer observed and recorded whether the spouse (which was in all cases the husband) or other adults were present in the following format: 0 = spouse not present, 1 = spouse present; 0 = no other adults present, 1 = other adults present.

Factors potentially involved in encoding and recall

Regular daily household routine. This was assessed by asking ‘During a day you have to do many things like preparing food, taking care of the child and the animals, etc. Do you carry out these things in the same order each day?’ (0 = *no*; 1 = *yes*).

Frequent task interruptions. First, participants were asked whether they regularly carry out each of the five tasks. For each task carried out regularly, participants were asked ‘How often does it happen that while you are carrying out the task something happens which interrupts you in carrying out the task, such as another task, another person or an animal?’ (0 = *never* to 1 = *(almost) always;* Cronbach’s α =.82).

Estimation tendency. To assess the participants’ general estimation tendency (i.e. under-, over- or accurate estimation), they were asked to estimate the frequency of an unrelated event.

That is, during the interview, participants were asked 'How are you feeling?' five times. At the very end of the interview participants were then asked 'During the interview, how many times did I ask you how you are feeling?' and the stated number was recorded. Responses lower than five indicated a tendency to under-estimate, five indicated a tendency to accurately estimate and those higher than five indicated a tendency to over-estimate.

Factors potentially involved in cognitive dissonance processes

Handwashing knowledge. This was measured by asking 'Can you tell me how you can prevent getting diarrhoea?' (Contzen & Mosler, 2013). If a respondent mentioned a key time for handwashing, one point was assigned. Points were summed up separately for stool- and food-related key times and rescaled to 0 = *no key time mentioned* to 1 = *all key times mentioned*.

Rationalisation. Rationalisation was measured with six items based on previous research (Fotuhi et al., 2013; Keutzer, 1968; McMaster & Lee, 1991; Olshavsky & Summers, 1974), such as 'Diarrhoea is not as dangerous as handwashing promotions claim' (-1 = *strongly disagree* to 1 = *strongly agree;* Cronbach's α =.72).

Interaction term handwashing knowledge and rationalisation. Interaction between health knowledge and rationalisation was computed by multiplying the corresponding items (handwashing knowledge and rationalisation) separately for SRH and FRH. Items were not centred as both had a meaningful zero point, namely no knowledge and neutral position regarding rationalisation (Cohen, Cohen, West, & Aiken, 2003).

Loaded question wording, forgiving wording and permissive and restrictive contexts

Four different questionnaire versions were applied randomly. The first version used only a loaded question wording by asking 'How often does it happen that you *don't* wash your hands with soap before handling food or after contact with stool?' (0 = *almost never/0–1 out of 10 times* to 1 = *almost always/9–10 out of 10 times*). The same item – let us name it item A – was used in the other three versions in combination with an additional item per version. The second version measured forgiving wording by introducing the item A with the sentence 'Many people don't have the time to always wash their hands with soap before handling food and after contact with stool'. The third version applied a permissive context by asking the following question ahead of the item A: 'Do you agree with the following statement: "It does not pay to wash hands with soap before handling food and after contact with stool"?' (0 =

don't agree; 1 = *agree*). A restrictive context was assessed in the fourth version by asking the following question before the item A: 'Do you agree with the following statement: "Only women who wash hands with soap before handling food and after contact with stool are caring mothers"'. All items were based on previous research (Näher & Krumpal, 2012; Tourangeau & Smith, 1996).

Script-based covert handwashing recall

Script-based covert handwashing recall (SBCR) was measured as follows. Short sequences of daily routines representing handwashing key times were presented to the respondents who were asked to explain in as much detail as possible how they usually carry out these routines. The following is an example item:

> Imagine you have just finished feeding the goats. Now your child is hungry and you have to feed it. Please describe exactly what you do from the moment you leave the goats' house until you feed the child.

Data collectors recorded whether the respondent mentioned handwashing with soap during the description of their routine. Four items were applied for SRH (Cronbach's α =.81) and five items were applied for FRH (Cronbach's α =.86); these were later averaged. Sum-scores ranged from 0 = *handwashing mentioned in 0%* to 1 = *handwashing mentioned in 100%* of the routine descriptions.

Over-reports in SBCR of SRH and FRH

Over-reporting in SBCR was calculated analogous to over-reports in self-reporting. Observed values were subtracted from the SBCR values for each individual and separately for SRH and FRH. Response scales also ranged from -1 = *100% underreporting* over 0 = accurate reporting to 1 = *100% over-reporting.*

Data analysis method

All analyses were run using IBM SPSS Statistics 22. To test whether SDR and additional factors were associated with over-reported handwashing (H1–H10; Q1–Q2), Pearson correlations and point-biserial correlations were calculated. H11 regarding the interaction between health knowledge and rationalisation was tested by means of partial correlations controlling for health knowledge and rationalisation. All analyses were tested separately for SRH and FRH. Furthermore, respondents with the value 1 in observed SRH or FRH (i.e. full handwashing compliance) were excluded from analyses. This was done for the following reasons: (1) no over-reporting was possible for respondents with full observed compliance because the self-report measure scale ended with the category of full compliance; (2) some of the hypotheses were restricted to respondents with imperfect compliance (H9–H11) and (3) some factors were assumed not only to explain over-reporting but also to cause behaviour (i.e. social norms) and thus these factors were expected to be high among respondents who over-reported as well as those who fully complied with the observations, that is, respondents who could not over-report.

To investigate whether additional factors explain over-reporting beyond SDR, several multiple regression models were run separately for SRH and FRH. Only factors significantly correlated with over-reporting were considered. A first model (Model A) tested the amount of variance in over-reporting explained by SDR factors. A second model tested whether the inclusion of factors related to encoding and recall explain additional variance in over-reporting. A third model tested whether the addition of dissonance factors to Model A increases the amount of explained variance in over-reporting. A fourth and final model (full model) tested the increase in explained variance in over-reporting when all additional variables (encoding, recall and dissonance) were added to Model A. To increase estimation accuracy, the regression models were tested using bootstrap estimation with 10,000 resamples. Again, respondents with the value 1 in observed SRH or FRH (i.e. full handwashing compliance) were excluded from analyses.

Whether alternative self-report measures, which were thought to reduce the influence of SDR and recall errors, mitigate the response bias was assessed as follows. To test H12-1, a dependent t-test compared loaded question wording to standard self-reported handwashing (averaged SRH and FRH). An independent t-test compared forgiving wording (with loaded question wording) to loaded question wording alone, testing H12-2. An analysis of variance compared a permissive and a restrictive context (both with loaded question wording) to loaded question wording alone (H12-3 and H12-4). To test H13, a dependent t-test compared script-based covert recall to standard self-reported handwashing separately for SRH and FRH. All tests applied bootstrapping with 10,000 resamples.

Results

While self-reported handwashing at key times was rather high (mean values between M = 0.60 and M = 0.73), observed handwashing at key times was low (mean values between M = 0.07 and M = 0.23; see Table 35). Accordingly, over-reporting in handwashing at key times was also high with mean values between M = 0.47 and M = 0.63. This means that respondents reported around 50–60% more handwashing than they actually performed. Over-reporting was higher with regard to food- than to stool-related key times. The highest mean value was found for handwashing before eating and the lowest mean value was found for handwashing after defecation or urination. Self-reported and observed handwashing were significantly correlated for all stool-related key times. For food-related key times, however, the two measures were significantly correlated only for two key times, namely before preparing food and before breastfeeding a child.

Table 35. Descriptive statistics and Pearson correlations for self-reported handwashing and observed handwashing, and descriptive statistics for over-reporting at key times.

		SRHW		*OHW*			*OvR*	
Key time	*N*	*M*	*SD*	*M*	*SD*	*r SRHW -OHW*	*M*	*SD*
Stool-related key times (mean)	235	0.72	0.26	0.22	0.40	.27***	0.48	0.42
After defecation or urination	190	0.68	0.30	0.21	0.40	.32***	0.47	0.42
After wiping a child's bottom	71	0.73	0.31	0.23	0.42	.28**	0.50	0.45
After other kinds of contact with stool	62	0.70	0.28	0.19	0.40	.24*	0.50	0.43
Food-related key times (mean)	542	0.66	0.25	0.10	0.23	.17***	0.57	0.33
Before eating	305	0.70	0.28	0.07	0.26	-.02	0.63	0.39
Before preparing food	420	0.69	0.28	0.17	0.36	.22***	0.52	0.41
Before breastfeeding a child	207	0.66	0.31	0.06	0.21	.19**	0.60	0.34
Before feeding a child	337	0.68	0.29	0.08	0.26	.05	0.61	0.38
Before handling drinking water	225	0.60	0.30	0.10	0.29	.05	0.50	0.41

Note. SRHW = Self-reported handwashing. OHW = Observed handwashing. OvR = Over-reporting. *** $p \leq .001$. ** $p \leq .01$. * $p \leq .05$. One-tailed significance levels are presented.

Factors associated with over-reporting

In terms of the first global research question whether SDR and additional factors are associated with over-reported handwashing, Table 36 presents correlations between over-reporting and potentially associated factors. With regard to SDR as a personality characteristic, scores in the MCSDS and need for conformity were both positively correlated with over-reporting in SRH and FRH, supporting H1 and H2. However, contrary to what we had hypothesised in hypothesis H3, a feeling of affiliation was not related with over-reporting in SRH and FRH. In line with the conceptualisation of SDR being dependent on an item's sensitivity, descriptive and injunctive norms were positively correlated with over-reporting in SRH and FRH (H4 and H5). Neither the presence of the husband nor the presence of other adults was related with over-reporting in SRH and FRH, thus negating Q1 and Q2 that tested SDR as a situational characteristic. With regard to factors affecting encoding and recall, a regular daily household routine was negatively correlated only with over-reporting in SRH but not with over-reporting in FRH, supporting H6 only partly. Frequent task interruption was correlated with over-reporting in SRH and FRH; however, against expectations (H7), the correlations were negative. A person's estimation tendency was positively correlated with over-reporting in both SRH and FRH, thus supporting H8. In terms of dissonance processes, health knowledge was positively related with over-reporting in FRH but was not related with SRH, supporting H9 only partly. In line with H10, however, rationalisation was negatively correlated with both over-reporting in SRH and FRH.

According to partial correlations of over-reporting with the interaction term of health knowledge and rationalisation while controlling for health knowledge and rationalisation, health knowledge and rationalisation were not interacting with regard to over-reporting in SRH and FRH; $r_{\text{stool}} = -0.03$, $p = .346$; $r_{\text{food}} = 0.03$, $p = .273$. H11 was thus not supported. Those variables significantly associated with over-reporting were included in the subsequent regression models, including frequent task interruptions, although contrary to expectations, this factor was negatively associated with over-reporting.

Factors explaining over-reporting beyond SDR

With regard to the second global research question regarding whether additional factors explain over-reporting beyond SDR, variance in over-reporting in SRH and FRH was significantly explained by SDR factors (see Model A in Tables 37 and 38). By adding encoding and recall factors, explained variance increased significantly for both over-reporting in SRH and FRH (see Model A+1 in Tables 37 and 38). Explained variance in over-reporting in SRH and FRH also increased when including dissonance factors to the SDR factors; however, the increase was significant only for over-reporting in FRH but not in SRH (see Model A+2 in Tables 37 and 38). When adding all additional factors (i.e. encoding, recall and dissonance factors) to the SDR factors, the increase in explained variance was significant for both over-reporting in SRH and FRH (see Model A+3 in Tables 37 and 38).

Table 36. Descriptive statistics and Pearson correlations for stool-related over-reporting (below diagonal) and food-related over-reporting (above diagonal) with predictor variables.

Variable	OvR	MCSDS	NC	FOA	DN	IN	PH[a]	PA[a]	RDR[a]	FTI	ET	HK	RA	*M*[b]	*SD*
OvR		**0.18**	**0.15**	0.04	**0.45**	**0.31**	-0.03	-0.02	0.04	**-0.14**	**0.16**	**0.18**	**-0.31**	0.59	0.28
MCSDS	**0.24**		-0.04	-0.07	**0.24**	**0.10**[c]	0.02	0.03	**0.09**[d]	**0.20**	0.02	**0.19**	0.04	0.56	0.18
NC	**0.17**[c]	-0.04		**0.35**	**0.21**	**0.31**	-0.04	-0.02	**0.10**[c]	**-0.09**[d]	**0.10**[d]	**0.15**	**-0.19**	0.85	0.15
FOA	-0.11	-0.06	**0.42**		**0.12**[c]	**0.17**	0.01	-0.01	**0.15**	**-0.12**[c]	**0.13**[c]	**-0.08**[d]	**-0.13**[c]	0.85	0.14
DN	**0.58**	**0.25**	**0.15**[c]	-0.01		**0.41**	-0.01	-0.02	0.02	**-0.14**	**0.18**	**0.18**	**-0.34**	0.66	0.23
IN	**0.43**	0.01	**0.36**	**0.16**[d]	**0.46**		0.06	**0.09**[d]	0.06	0.06	**0.15**	**0.09**[d]	**-0.23**	0.83	0.19
PH[a]	-0.07	-0.02	-0.06	0.00	0.02	0.01		-0.06	0.04	**0.17**	-0.04	0.02	-0.01	32%	
PA[a]	0.02	0.02	0.00	-0.01	0.04	**0.16**[d]	-0.09		0.00	-0.01	-0.03	0.04	**0.09**[d]	18%	
RDR[a]	**-0.12**[d]	-0.02	0.09	**0.14**[d]	0.00	-0.02	0.07	-0.07		-0.04	**-0.08**[d]	-0.03	**-0.08**[d]	77%	
FTI	**-0.14**[d]	**0.20**[c]	-0.03	-0.01	-0.04	0.10	0.10	0.03	0.03		-0.05	-0.02	**0.36**	37	0.22
ET	**0.17**[c]	0.03	**0.16**[d]	**0.17**[c]	**0.24**	**0.22**	-0.01	-0.05	0.01	-0.06		**0.08**[d]	**-0.17**	5.55	3.82
HK	0.02	0.10	0.08	0.07	**0.19**[c]	0.10	-0.02	0.04	0.09	**0.26**	-0.04		**-0.28**	0.20	0.29
RA	**-0.33**	0.01	**-0.19**[c]	-0.10	**-0.40**	**-0.23**	-0.09	0.11	-0.10	**0.30**	**-0.22**	-0.05		-0.40	0.43
M[b]	0.66	0.56	0.83	0.84	0.65	0.79	30%	20%	76%	0.39	5.49	0.31	-0.30		
SD	0.26	0.17	0.16	0.14	0.22	0.24				0.23	4.27	0.29	0.45		

Note. N stool-related over-reporting = 183. *N* food-related over-reporting = 525. OvR = Over-reporting; MCSDS = Marlowe-Crown social desirability scale; NC = Need for conformity; FOA = Feeling of affiliation; DN = Descriptive norm; IN = Injunctive norm; PH = Presence of husband; PA = Presence of adults; RDR = Regular daily routine; FTI = Frequent task interruptions; ET = Estimation tendency; HK = Health knowledge; RA = Rationalisation. [a] Correlations are point biserial correlations. [b] For the dichotomous variables 'presence of husband', 'presence of adults' and 'regular daily routine', percentages are presented instead of means. Boldface: significant with $p \leq .001$, except for the following: [c] $p \leq .01$; [d] $p \leq .05$. One-tailed significance levels are presented except for PH and PA.

Table 37. Factors explaining stool-related over-reporting: multiple regression results

Variable	Model A (SDR only) *B*	Model A+1 (encode/recall) *B*	Model A+2 (dissonance) *B*	Model A+3 (full model) *B*	90% CI
Constant	-0.03	0.06	-0.01	0.08	[-0.09, 0.24]
MCSDS	0.19 *	0.25 **	0.21 **	0.26 **	[0.11, 0.41]
Need f. conformity	0.05	0.05	0.03	0.04	[-0.12, 0.21]
Descriptive norm	0.54 ***	0.50 ***	0.48 ***	0.47 ***	[0.33, 0.61]
Injunctive norm	0.24 **	0.27 ***	0.24 **	0.27 ***	[0.14, 0.39]
Regular daily routine	–	-0.07 *	–	-0.07 **	[-0.13, -0.02]
Frequent task interrupt.	–	-0.20 **	–	-0.17 **	[-0.29, -0.06]
Tendency to over-estim.[a]	–	0.00	–	0.00	[-0.01, 0.01]
Rationalisation	–	–	-0.07 *	-0.05 †	[-0.11, 0.01]
R^2	.39	.43	.40	.44	
F	29.69***	19.86***	24.83***	17.69***	
Δ R^2 compared to Model A		.04	.01	.05	
Δ *F* compared to Model A		4.50**	3.69†	3.86**	

Note. $N = 189$. CI = Confidence interval. † $p \leq .10$. *** $p \leq .001$. ** $p \leq .01$. * $p \leq .05$. One-tailed significance levels are presented except for the constant and for frequent task interruptions. [a] Answer scale ranged from 0 to infinite.

Table 38. Factors explaining food-related over-reporting: multiple regression results

Variable	Model A (SDR only) *B*	Model A+1 (encode/recall) *B*	Model A+2 (dissonance) *B*	Model A+3 (full model) *B*	90% CI
Constant	-0.01	0.03	0.02	0.04	[-0.08, 0.15]
MCSDS	0.12 *	0.17 **	0.15 **	0.16 **	[0.07, 0.28]
Need f. conformity	0.06	0.04	0.03	0.01	[-0.10, 0.14]
Descriptive norm	0.46 ***	0.41 ***	0.38 ***	0.36 ***	[0.28, 0.45]
Injunctive norm	0.21 ***	0.23 ***	0.19 **	0.20 **	[0.10, 0.30]
Frequent task interrupt.	–	-0.16 **	–	-0.10 *	[-0.19, -0.01]
Tendency to over-estim.[a]	–	0.01 †	–	0.00	[0.00, 0.01]
Health knowledge	–	–	0.05 †	0.05 †	[-0.07, 0.11]
Rationalisation	–	–	-0.11 ***	-0.09 **	[-0.14, -0.04]
R^2	.23	.25	.26	.27	
F	39.02***	28.82***	30.45***	23.75***	
Δ R^2 compared to Model A		.02	.03	.04	
Δ *F* compared to Model A		6.72**	10.49***	6.75***	

Note. $N = 526$. CI = Confidence interval. † $p \leq .10$. *** $p \leq .001$. ** $p \leq .01$. * $p \leq .05$. One-tailed significance levels are presented except for the constant and for frequent task interruptions. [a] Answer scale ranged from 0 to infinite.

In this last model, explained variance in stool-related over-reporting was significantly accounted for by three SDR factors (MCSDS and descriptive and injunctive norms) and two encoding and recall factors (regular daily routine and frequent task interruptions). The dissonance factor rationalisation explained over-reporting in SRH only marginally. For over-reporting in FRH, the same SDR factors (MCSDS and descriptive and injunctive norms), one encoding and recall factor (frequent task interruptions) and one dissonance factor (rationalisation) significantly explained over-reporting. As in all models, explained variance was higher for over-reporting in SRH than in FRH. Still, for both full models the effect sizes were large; $f^2_{\text{stool}} = .78$; $f^2_{\text{food}} = .37$ (cf. Cohen, 1992).

Alternative self-report measures to mitigate over-reporting

Our last global research question was as follows: Do alternative self-report measures, thought to reduce the influence of SDR and additional factors, mitigate the response bias? None of the alternative self-report measures thought to counteract SDR successfully reduced a responsebias. In more detail, loaded question wording (M = 0.74, SD = 0.25) did not significantly differ from standard self-reports (M = 0.71, SD = 0.23); t (143) = 1.43, p >. 05, d = 0.12. The same is true with regard to forgiving wording with loaded question wording (M = 0.77, SD = 0.23) compared to loaded question wording alone (M = 0.74, SD = 0.25); t (282) = -1.07, p >. 05, d = 0.13. Furthermore, no differences were found between questions applying a permissive (M = 0.75, SD = 0.27) or a restrictive context (M = 0.74; SD = 0.27) with loaded question wording or loaded question wording alone (M = 0.74, SD = 0.25); F(2, 411) = 0.08, p > .05, η^2 = .00. That is, H12-1 to H12-4 were all not supported.

In contrast to these results and supporting H11, when compared to standard self-reports over-reporting was indeed smaller for SBCR, which was assumed to mitigate recall errors and SDR. In more detail, over-reports in stool-related standard self-reports (M = 0.50, SD = 0.41) were significantly larger than over-reports in stool-related SBCR (M = 0.16, SD = 0.50); t(231) = 11.72, p < .001, d = 0.78. The same is true for over-reports in food-related standard self-reports (M = 0.56, SD = 0.31) compared to over-reports in food-related SBCR (M = 0.24, SD = 0.43); t(541) = 19.67, p < .001, d = 0.88. However, at the same time the standard deviations of over-reporting were larger for SBCR than for standard self-reports. In other words, SBCR increased response accuracy only on the aggregated level and not on the individual level.

Discussion

The present study aimed to better understand the causes and underlying mechanisms of over-reported handwashing in order to obtain indications for measures to mitigate the response bias. Socially desirable responding, generally thought to be the main source of over-reported handwashing (Ram, 2013), and factors involved in encoding and recall of information and dissonance processes were investigated as potential explanatory variables. Furthermore, alternative self-report measures, thought to reduce the influence of socially desirable responding and recall errors, were tested with regard to their mitigating capacity. The following three global research questions were addressed: (1) Are socially desirable responding and additional factors associated with over-reported handwashing?; (2) do additional factors explain over-reporting beyond socially desirable responding?; and (3) do alternative self-report measures mitigate the response bias?

Factors associated with over-reported handwashing

Overall, over-reporting was quite high, particularly for food-related key times. With regard to the first global research question, several of the factors thought to increase socially desirable responding were correlated with over-reporting in both stool- and food-related handwashing. First, a socially desirable response style was positively associated with over-reported handwashing. This is in line with previous research that found associations with self-reported hygiene behaviour (Stevenson et al., 2009) and other preventive health behaviours (Kristiansen & Harding, 1984). Second, reflecting the assumed underlying mechanism of a socially desirable response style, namely a need to conform to social standards or a need for approval (Crowne & Marlowe, 1960; DeMaio, 1984), need for conformity was also positively associated with over-reported handwashing. However, the assumption that conforming to social standards (i.e. socially desirable responding) should be especially high when people feel strongly attached to their social in-group (Turner et al., 1987) was not supported; feeling of affiliation was not associated with over-reported handwashing. Furthermore, over-reporting was positively correlated to injunctive and descriptive norms. This corresponds to the view that socially desirable responding depends on a question’s sensitivity or its normative loading (Tourangeau & Yan, 2007). It is also in line with previous research that found descriptive norms to be associated with socially desirable answers regarding election participation or cheating (Näher & Krumpal, 2012). However, the presence of the husband or other adults during the interview, potentially increasing (or decreasing) socially desirable responding due to sensitive questions, was not associated with over-reporting in stool- and food-related handwashing. Previous research on this subject is mixed, meaning that the presence of third parties led to responses that were *more* socially desirable, *less* socially desirable or uninfluenced (e.g. Aquilino, 1997; Aquilino et al., 2000; Silver, Abramson, & Anderson, 1986). It is possible that in the present project, responses were not influenced by the presence of third parties because personal privacy and confidentiality is usually neither common nor highly valued in developing countries, especially in rural areas (Hershfield, Rohling, Kerr, & Hursh-César, 1993). Alternatively, it is possible that the influence of the presence of a stranger, namely the interviewer, on the responses was as high that the influence of third parties was obliterated.

Factors assumed to cause a response bias through encoding and recall processes were (partly) associated with over-reported handwashing, but not always as hypothesised. First, a regular daily routine was negatively correlated to stool- but uncorrelated to food-related over-reporting. Our hypothesis that a regular daily routine facilitates remembering to perform handwashing and thus yields more accurate behaviour encoding and reporting was thus only partly supported. The influence of a regular daily routine on over-reported handwashing should be further investigated, preferably by using a multi-item interval scaled measure instead of the applied single-item dichotomous measure. Frequent task interruption was associated with over-reports in both stool- and food-related handwashing. However, contrary to our hypothesis the association was negative, meaning that respondents who were frequently interrupted in their tasks tended to over-report less than those who were rarely interrupted. It might be that frequently interrupted respondents were, against expectations, *less* likely to forget handwashing without noticing. Maybe since these people were interrupted more often during their routines, they had started and performed their key activities more consciously. If so, they would have remembered their good intentions to wash their hands more often, or at least they would have realized more often that they had forgotten to wash their hands in time (i.e. when they already had started a key activity and thus had missed the key time for handwashing) than people who followed their routines more unconsciously. Therefore, the self-reports of the former would have been more accurate than those of the latter because the information they encoded was already more accurate. Such an interpretation finds some support in the fact that frequent task interruption was positively correlated with self-reported forgetting (r = .30, p < .001). Over-reporting in stool- and food-related handwashing was additionally correlated with a person’s general estimation tendency, meaning that compared to a person that did not over-estimate the frequency of an unrelated event, a person who did over-estimate showed more over-reporting with regard to handwashing. This parallels the finding that people usually differ in their memory performance (Loftus et al., 1992; Unsworth & Engle, 2007).

Finally, over-reporting was also (partly) associated with factors assumed to affect responses by dissonance processes. According to our expectations, rationalisation was negatively correlated with both stool- and food-related over-reporting. Health knowledge, however, was only positively correlated with food-related but unrelated to stool-related over-reporting. This result partly supports the notion that experiencing dissonance might result not only in behaviour change or rationalisation (Festinger, 1962) but might also cause *over-reporting* (or underreporting) to restore consonance (Näher & Krumpal, 2012; Tagliacozzo, 1979).

That dissonance processes might contribute to over-reported handwashing might also be of interest for handwashing interventions. While the influence of socially desirable responding should be limited to situations with social interaction, dissonance induced over-reporting can be expected to be rather situation-independent because the over-reports are thought to represent a person's genuine behavioural cognitive element; this might be exploited in handwashing interventions. If over-reporting is caused by the situation-dependent socially desirable responding, pointing out to a respondent that self-reports are inflated compared to observed behaviour will most likely have little effect on subsequent (private) behaviour. Furthermore, although such an approach might be questioned due to ethical reasons, the social environment might be informed about the over-reporting so as to increase the social pressure to act in a socially desirable manner (i.e. to change behaviour). However, when over-reporting reflects dissonance reduction, informing the respondent about inflated self-reports might cause additional dissonance, which may be resolved by actual behaviour change. In fact, in a study on energy conservation, behaviour was effectively changed by informing participants about the *inconsistency* of their previously measured positive attitudes towards conservation with their actual high consumption of electricity (Kantola, Syme, & Campbell, 1984).

One factor which was assumed to be majorly contributing to over-reported handwashing, unnoticed forgetting to wash hands, was only indirectly tested by the factors 'regular daily routine' and 'frequent task interruptions'. Whether forgetting is affecting handwashing frequency as outlined and whether it is adding to the response bias might have been investigated by means of a simultaneous application of observations with qualitative interviews in which retrospective reports are obtained immediately when handwashing is omitted. Such an approach was not feasible within the present study as it was expected to induce reactivity (i.e. respondents will change their behaviour) what would have biased the remainder of the observation. Further complicating this issue is that in retrospective reports forgetting might be stated not only when forgetting caused the lapse but also as a socially acceptable excuse for lapses caused, for example, by a lack of time or motivation (Tedesco, Keffer, & Fleck-Kandath, 1991). However, to investigate the influence of forgetting (and other encoding and recall errors) on over-reporting in handwashing, in a future study it could be compared with over-reporting in another preventive health behaviour which is equally socially desirable[26] but for which encoding and recall errors are thought to be less pronounced, such as solar water disinfection.

Altogether, not only socially desirable responding processes (i.e. socially desirable response style, need for conformity and injunctive and descriptive norms) but also encoding and recall factors (regular daily routine, frequent task interruptions and general estimation tendency) as well as dissonance processes (health knowledge and rationalisation) were associated with over-reported handwashing. These additional factors explained over-reported handwashing beyond socially desirable responding. The gained knowledge about factors explaining over-reported handwashing might be used to deduce measures mitigating the response bias in self-reported handwashing by reducing the influence of the respective factors.

Methods to mitigate over-reported handwashing

As previously mentioned, the following three approaches are possible to mitigate the influence of factors causing a response bias: (1) statistical control of causing factors; (2) optimisation of the interview situation and (3) improvement of the self-report measures. These are discussed further below.

Control statistically for causing factors

It has been suggested to control for the influence of a socially desirable response style by partialling out its effect with the use of multiple regression analysis or partial correlations (King & Bruner, 2000; Paulhus, 1991). In principal, this method could be applied for all factors found to be associated with over-reported handwashing. However, some of the factors

[26] Previous studies investigating socially desirable responding assessed the social desirability of items by letting respondents rate the items' desirability (DeMaio, 1974). Similarly, the desirability of preventive health behaviours could be measured and compared. Alternatively, prevalent social norms indicate how socially desirable abehaviour is.

explaining over-reporting are also thought to determine behaviour (including handwashing), namely social norms and health knowledge (Curtis et al., 2009; Festinger, 1962, 1968; Fishbein & Ajzen, 2010). By partialling out their effects on self-reported handwashing, one would risk to control not only for response biases (i.e. over-reporting) towards social norms and health knowledge, but also for truly high behaviour which was facilitated by social norms and health knowledge. For the remaining factors (i.e. socially desirable response style, need for conformity, regular daily routine, frequent task interruptions, general estimation tendency and rationalisation), statistical control would be feasible. However, the explanatory power of these factors regarding over-reporting was rather mediocre and thus the accuracy in self-reports would improve only negligibly.[27]

Optimize the interview situation to reduce socially desirable responding

Instead of controlling for socially desirable responding *after* data collection, it could be controlled for *during* data collection, namely by optimizing the survey situation. First, the perceived privacy or confidentiality during data collection could be increased (Tourangeau & Yan, 2007). However, according to the present study in which the presence of third parties (i.e. husband and other adults) had no influence on over-reporting (see above), to ensure that third parties are not present during the interview seems to be not very relevant in social and cultural contexts similar to the one under study. On the other hand, the influence of the presence of a stranger (i.e. the interviewer) was not tested here (due to feasibility issues), although it might have had a major influence on over-reporting. Unfortunately, the option to apply self-administered questionnaires (Tourangeau & Yan, 2007) is often not feasible in developing countries due to high illiteracy, as was the case in the present study (Bulmer & Warwick, 1993). Alternatively, at least for closed questions, interviewers could only read the questions while respondents could record their answers themselves on rating scales applying smileys or minus and plus signs as symbolic labels instead of words (McDowell, 2006). Such an approach should be tested in future research.

An approach which was successfully applied in previous studies to reduce socially desirable responding is the use of the bogus pipeline procedure in which respondents are made to believe that the interviewers will learn their true status on the behaviour in question regardless of the self-reports because an additional measure (e.g. a biological assay or a

[27] With regard to a socially desirable response style, however, there is evidence that it interferes with behavioural health interventions, probably because these people over-estimate their self-control abilities (Carels, Cacciapaglia, Rydin, Douglass, & Harper, 2006). Accordingly, health behaviour interventions, including handwashing interventions, might benefit from taking a socially desirable response style into account by tackling the potentially over-estimated self-control abilities by appropriate interventions.

polygraph-like device) is purportedly applied (Tourangeau & Yan, 2007).[28] It can be argued that it is unethical to use the bogus pipeline procedure as respondents are deceived; still, it might be interesting to test its practicability in future studies, for example, by purportedly co-measuring microbiological hand contamination, an instrument which is sometimes applied as a proxy measure for handwashing (Ram, 2013). Alternatively, one could try to explicitly and extensively inform respondents about the tendency of people to give a socially desirable response instead of a true response while also emphasizing the dangers this entails as the true status and the needs in a community may be blurred such that the provision of essential help for the community may be forestalled only because individuals present themselves in a positive light. Therewith, respondents might feel more inclined to give more accurate responses so as to serve the needs of their communities.

Improved self-report measures

The influence of some of the factors associated with over-reported handwashing could also be mitigated by improved self-report measures. With regard to socially desirable responding, alternative question wording has been suggested in the literature (Tourangeau & Yan, 2007). These were tested in the present study. However, none of these alternative wordings (i.e. loaded question wording, forgiving wording and a permissive question context) influenced self-reported handwashing. Correspondingly, previous research on alternative question wording often revealed only limited effects on socially desirable responding (for overviews, see Holbrook & Krosnick, 2010; Tourangeau & Yan, 2007). Moreover, there is some anecdotal evidence from the present study that the negation used in the loaded question wording (which was applied in all alternative wordings) caused some confusion among respondents and interviewers. Overall, the applied alternative question wordings seem to be ineffective in mitigating over-reported handwashing; if still applied, the use of negations should be avoided.

The influence of recall errors (in addition to social desirable responding) was also targeted with an alternative self-report measure, i.e. a script-based covert recall. While mean over-reporting in this script-based covert recall was indeed smaller than in conventional self-reports, the variance in over-reporting was even higher. In other words, the new measure was more accurate only on the aggregated level but not on the individual level, probably because

[28] In the present study data collectors did learn the respondents' 'true' status in handwashing as it was also observed. However, when applying the bogus pipeline the respondents are explicitly informed that their true scores will be detected (even when they are not; Roese & Jamieson, 1993). This was not done in the present study, which explains why over-reporting was high even though respondents were observed prior to the interview.

of frequent *under*-reporting. It is possible that washing hands, especially for habitual handwashers, is such a natural component of these situations that it seemed not worth mentioning.

There are alternative instruments which are thought to increase the recall accuracy which were not applied in the present research but which could be tested in future studies. First, 24-hour recalls, often used in dietary intervention studies (e.g. Moshfegh et al., 2008), could be applied. When using these recalls the respondents are asked backwards (i.e. starting with the most recent activity) about the performed activities relevant to handwashing (e.g. food preparation) in the last 24 hours; as a result, the time and occasion of the events should serve as cues and facilitate remembering. For each activity it would be recorded whether hands were washed or not. Alternatively, weekly recall diaries might be used (Heeb & Gmel, 2005); that is, respondents could be provided with a structured form and asked to record each evening (during the course of one week) how many times they performed each key event and how many times they had washed their hands at each key event. While both measures are thought to increase recall accuracy, they will not mitigate socially desirable responding or encoding errors. Furthermore, the latter measure, as respondents are more aware about handwashing, might cause reactivity and thus change behaviour. Still, their applicability could be tested in future studies and could perhaps be combined with the outlined approaches to mitigate socially desirable responding (see above).

Strengths, limitations and perspectives

While the difficulties involved in measuring handwashing by self-reports are widely known (e.g. Biran et al., 2008; Ram, 2013), this is the first paper that examines factors potentially explaining over-reported handwashing. In so doing, we examined not only socially desirable responding, the factor usually stated to be responsible for the bias (Ram, 2013), but considered additional factors which are not only involved in responding itself (as is social desirability) but also in the encoding, retrieval and integration of the relevant information.

Also, alternative self-report measures were tested which were expected to mitigate socially desirable responding and/or recall errors. While none of the applied measures increased response accuracy, alternative measures which were discussed should be tested in future research.

Many studies investigating responding biases do not assess the bias directly by comparing self-reports with another criterion thought to be more objective; rather, they assume that, for example, the reporting of lower voting rates indicate less socially desirable responding (e.g. Näher & Krumpal, 2012). While such an approach might be adequate in many situations, one runs the risk of misinterpreting individual differences in responses as differences in accuracy even though the individual differences might be caused by actual differences in behaviour (see also Schwarz & Oyserman, 2001). The present study assessed over-reporting rather directly by comparing self-reported behaviour with observed behaviour.[29] As a result, we were able to investigate the explanatory factors' *actual* effects on over-reporting isolated from the effects the factors (e.g. social norms) might also have on actual behaviour and thus responding.

Furthermore, the present study took care to ensure the comparability of the measures used for observed and self-reported behaviour to the greatest possible extent. That is, self-reported and observed behaviour were measured on the same day and similar response scales in interviews and recording formats in observations were applied. The latter means that (separately for each key event) self-reports and observations yielded percentages of times in which one washes hands out of all the times in which hands should have been washed. While the warranty of comparability seems rather basic, it is not necessarily a given. In previous studies that compared self-reported and observed behaviour, answer scales and observation formats were hardly comparable (e.g. Biran et al., 2008; Halder et al., 2010; Manun'Ebo et al., 1997), which may have caused an over- or underestimation of the bias between self-reported and observed data. Furthermore, self-reports and observations were often measured on different days, sometimes up to two months apart (e.g. Halder et al., 2010; Manun'Ebo et al., 1997; Stanton, Clemens, Aziz, et al., 1987), so that differences due to measurement cannot be completely isolated from actual changes in behaviour over time. On the other hand, applying both measures on the same day may cause contamination between instruments; by first conducting the observation and then the interview, we tried to minimize observation contamination due to reactivity.

Still, some factors also limited the comparability in the present study. First, self-reports asked about handwashing with soap, while in the observational data handwashing compliance was restricted to washing *both* hands with soap. This might have increased over-reporting. Data should thus be reanalysed with observed handwashing compliance including washing one or both hands with soap. Furthermore, due to the usual daily routines of primary caregivers in the study region, who are rarely at home for more than three to four hours at a

[29] Whether observed behaviour is the most valid measure for actual behaviour and is thus the standard of comparison for other measures can be questioned. However, this was not within the scope of the present study.

time, observations lasted only for two-and-a-half hours. Within this time, however, repeated observation of one key time (e.g. food preparation) is rare. Accordingly, handwashing compliance at a specific key time was often determined by a single observation event. Self-reports, in contrast, asked for an integrated estimation of the handwashing frequency at a key time. While this limits comparability, it also questions the validity of the observed handwashing measure, which would only be given if observations were highly reliable (see below). Future studies investigating over-reported handwashing should try to further maximise the comparability between self-reported and observation measures.

Furthermore, the answer scale which was applied for self-reported handwashing to ensure comparability between observed and self-reported data involves the risk of obtaining a ceiling effect. That means that if over-reporting is very high, responses might be accumulated within the upper extreme of the answer scale (i.e. 4 = *almost always/9–10 out of 10 times*). Such a ceiling effect could be prevented by applying an open question format, such as ‘Within the last 24 hours, how many times did you wash your hands with soap and water?’. To still be able to calculate the ratio of times that hands were washed compared to times that handwashing was omitted, one would have to also assess the frequency of key events that happened within the last 24 hours.[30] While such an answer format prevents a ceiling effect, the combined application of two frequency estimates might increase inaccuracy due to the previously discussed problems involved in frequency estimations (see Introduction). Nevertheless, to investigate such an approach to measuring self-reported handwashing would be worthwhile.

A further limitation of the present study is that some factors were tested even though their measures’ internal consistencies were insufficient (i.e. MCSDS). Also, the internal consistency of the observation measures was not conclusively assessed. These measures’ internal consistencies should be further investigated.

Also, several of the assumed underlying mechanisms were not directly tested. This is especially the case for dissonance processes and for the influence of unnoticed forgetting of washing hands on over-reporting. While some ideas for future research regarding forgetting were already mentioned above, dissonance processes could be investigated by means of experimental research testing whether the induction of dissonance (e.g. by providing health

[30] One should take into account that the reported handwashing rate may entail handwashing occasions other than the key events (e.g. handwashing after eating) so that the ratio might over-estimate correct behaviour. However, asking separately for the handwashing rate at each key event within the last 24 hours would probably also yield over-reporting, as is usually the case when globally frequent behaviours are measured decomposed (see Introduction).

information) increases over-reporting (or under-reporting, depending on the health behaviour at hand).

Moreover, while many factors were considered in the present paper, several factors were not included even though they might affect over-reporting in handwashing, such as courtesy-bias, acquiescence tendency or question order. While some of these are rather unlikely to be relevant due to the response patterns found in the present study (e.g. acquiescence tendency), the factors should be investigated in subsequent studies.

An additional aspect which is essential regarding measurement but which it was not feasible to account for in the present paper is reliability. Self-reports tend to be over-reported, which questions their validity to measure actual handwashing. However, a measure also needs to be reliable, that is, consistent or repeatable; otherwise, a person's 'true' behaviour value is not assessable within a single measurement session, and behaviour change over time, which is essential to test an intervention's effectiveness, cannot be accurately assessed. A previous study tested the reliability of observational data and found that the repeatability of observed behaviour at the individual level between several observation sessions was generally low (Cousens et al., 1996). Future research should further investigate the reliability of self-reported and observed handwashing, that is, apply repeated measurement. If the observations' reliability was indeed found to be low, this would question the adequacy of applying single observation sessions to evaluate handwashing interventions. Furthermore, since self-reports might reflect a rather integrated behaviour assessment and a single observation session might be a more situation-dependent snapshot in time, it might be insightful to compare self-reported handwashing rates to the rates gained by several observation sessions (with the latter also reflecting a more integrated behaviour assessment).

Conclusion

The difficulties involved in measuring handwashing by self-reports and observations are widely known, one of them being the over-reporting in self-reported handwashing. The present paper is the first one investigating factors explaining over-reporting in handwashing; it also tested measures to mitigate over-reporting. While it delivers only initial results on a complex phenomenon, it contributes to a limited evidence base on a highly important subject: how to evaluate handwashing interventions efficiently and accurately. We hope that the present paper stimulates further research that examines over-reporting in handwashing and on alternative self-report measures to mitigate the response bias.

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Part Six

General discussion

1. Summary

The broad aims of this thesis were threefold: (1) to evaluate handwashing interventions in emergency aid; (2) to investigate the potential of theory- and evidence-based population-tailored interventions compared to standard approaches in DEA; and (3) to explore a major challenge for handwashing intervention evaluations, that is over-reporting in self-reported handwashing behaviour. Corresponding research questions were derived and addressed in six empirical studies based on three surveys, one in Haiti and two in Ethiopia. In the first two studies, the behavioural determinants of handwashing behaviour were explored based on two examples, Haiti and Ethiopia (Part Two). The gained information is relevant not only to get insights for developing theory-based interventions, but it is also useful in intervention evaluations. Second, current handwashing interventions in emergency relief and recovery were investigated in Haiti (Part Three). Thereafter, two handwashing interventions were developed based on theory and evidence and were tailored to the target population, the inhabitants of four Borena kebeles in southern Ethiopia (Part Four, Chapter I). The interventions were tested in a nonrandomised controlled trial in comparison to a standard approach, an education intervention (Part Four, Chapter I & II). The theory-based population-tailored interventions were revealed to change handwashing behaviour more effectively than the standard approach (Part Four, Chapter I). Accountable for the interventions’ effectiveness were their underlying change processes; the interventions successfully changed specific social-cognitive factors, which caused behaviour change (Part Four, Chapter II). Finally, while factors beyond socially desirable responding were found to explain over-reporting in self-reported handwashing, no alternative self-report measure was found that successfully mitigated over-reporting (Part Five).

In the remainder of this chapter, the main results of Parts Two to Five with regard to the respective research questions are recapitulated. Where indicated, additional findings are presented and first conclusions are drawn. In the following chapters, implications of this thesis’ findings with regard to (1) behaviour change theory and intervention research; (2) handwashing interventions in DEA; and (3) the measurement of handwashing in intervention evaluations are reflected. Further, the strength but also the limitations of this thesis are discussed. Part Six ends with a general conclusion.

1.1. Main findings Part Two: Social-cognitive determinants of handwashing

Studies 1 and 2 explored the social-cognitive determinants of handwashing in two populations, one in Haiti and one in Ethiopia, employing cross-sectional, correlative designs. Both populations were in the recovery phase of an emergency; in Haiti caused by the earthquake and the cholera outbreak in 2010; in Ethiopia caused by a major draught in the Horn of Africa in 2011-2012. To maximise comparability of the studies' results, only factors which were measured in both populations, i.e. in survey 1 as well as in survey 2, were explored.

A first major finding of the two studies is that handwashing behaviour is not a uniform behaviour but that it is possible to statistically distinguish between stool-related handwashing (after defecation, after handling child stool, cleaning a child's anus after defecation or after other contact with stool) and food-related handwashing (before preparing food, before breast-feeding a child, before eating and before handling drinking water).

To answer research question 1, which social-cognitive factors are related to domestic handwashing in Haiti and Ethiopia, Table 39 summarises the significant predictors of stool- and food-related handwashing in Haiti and Ethiopia according to multiple regression results.

Based on effect sizes, the most important predictors with regard to stool-related handwashing in Haiti were coping planning, commitment, health knowledge and disgust (affective belief). Health knowledge, however, was *negatively* associated with handwashing behaviour (this result will be discussed in more detail subsequently). Food-related handwashing was best explained by coping planning, social norms, impediments and forgetting. In Ethiopia, for stool-related handwashing, the most important predictors were nurture (instrumental belief), social norms, severity and impediments. Food-related handwashing was best explained by social norms, nurture, severity and forgetting. In both countries the tested social-cognitive factors explained stool- and food-related handwashing well.

With regard to research question 2, what are the similarities and differences in social-cognitive determinants of handwashing in these two countries, studies 1 and 2 revealed first of all similarities but also some differences. In both countries, handwashing (stool- and/or food-related) was significantly explained by disgust, social norms, motivational self-efficacy, impediments, coping planning, forgetting and commitment. However, severity and nurture were only relevant in Ethiopia. It might be that nurture, i.e. handwashing to protect and teach children, was more important in Ethiopia because only households with a child under the age of five years were surveyed, while this was not a selection criterion in Haiti. Similarly, in Ethiopia severity was (amongst others) assessed with regard to the child under the age of five years, what might explain the high importance. A further difference between the two countries is that coping planning was the most important social-cognitive factor in Haiti, while it was not among the strongest predictors in Ethiopia.

Table 39. Summary of the social-cognitive predictors of stool- and food-related handwashing in Haiti and Ethiopia according to multiple regression results

	Haiti		Ethiopia	
Variables	Stool-related HW	Food-related HW	Stool-related HW	Food-related HW
Vulnerability				
Severity			√ **	√ **
Health knowledge	√ ** (but negative)			
Instrumental belief scale		√		
Nurture			√ ****	√ ***
Affective belief scale		√		
Disgust	√ *		√	√
Social norms	√	√ ***	√ ***	√ ****
Motivational self-efficacy	√	√	√	√
Volitional self-efficacy				
Impediments	√	√ **	√ *	√
Coping planning	√ ****	√ ****	√	√
Forgetting	√	√ *		√ *
Commitment	√ ***	√	√	

Note. HW = Handwashing. √ = Factor significantly explained handwashing. Predictor strengths according to effect sizes: **** = Strongest predictor; *** = Second strongest predictor; ** = Third strongest predictor; * = Fourth strongest predictor.

In line with previous research (Aunger et al., 2010), in both countries stool- and food-related handwashing were partly explained by different social-cognitive factors. In Haiti, disgust and health knowledge were only relevant with regard to stool-related handwashing, while instrumental and affective belief scales only explained food-related handwashing. In Ethiopia, stool-related but not food-related handwashing was predicted by forgetting; the opposite is true for commitment.

In sum, social-cognitive factors explained handwashing behaviour in Haiti and Ethiopia well. While several factors were relevant in both countries and with regard to stool-and food-related handwashing, some factors were only or more relevant within one country or with regard to one type of handwashing.

1.2. Main findings Part Three: Standard handwashing interventions in emergency relief and recovery

Within a cross-sectional correlative design, study 3 evaluated the handwashing interventions that three INGOs had conducted in response to the earthquake and cholera outbreak in Haiti in 2010. Handwashing was promoted by 16 different intervention activities or communication channels, which largely focused on knowledge formation with regard to disease and its prevention (i.e. general information on behaviour-health link, BCT-1; describe likely material consequences of behaviour BCT-2; provide instructions BCT-16; Abraham, 2012). Detailed information on the interventions content was not available. Therefore, instead of investigating BCTs, the evaluation had to concentrate on communication channels (e.g. radio spot or pictures, poster, paintings) and activities (e.g. material distribution or hygiene training). It was not only investigated how far the channels and activities were associated with behaviour (what can be seen as a proxy for the interventions effectiveness) but also which social-cognitive factors mediated the associations.

Research question 3 asked: through which social-cognitive factors are intervention activities related with handwashing behaviour? Potential mediators were the social-cognitive factors associated with behaviour because only factors associated with an outcome can mediate an antecedent’s effect. Health knowledge, instrumental and affective beliefs (i.e. return, response efficacy, pleasantness of perfume and disgust), descriptive norm of the community, motivational self-efficacy, general impediments and coping planning explained stool-related handwashing. Food-related handwashing was explained by perceived severity, instrumental and affective beliefs (i.e. feeling attractive and pleasantness of perfume), family’s descriptive norm, injunctive norm, motivational self-efficacy, general impediments, coping planning and forgetting. Only one of these factors was not associated with any of the communication channels or activities, namely the *return* of adopting handwashing behaviour. In other words, return did not mediate the interventions’ associations with handwashing. The result that only one factor did not emerge as mediator is quite interesting because the available information on the interventions’ content might have suggested that mainly the risk factors (i.e. vulnerability, severity and health knowledge) and response efficacy beliefs would mediate the interventions’ association with behaviour. But in fact instrumental and affective beliefs, social norms, motivational self-efficacy, impediments, coping planning and forgetting all emerged as mediators. Further, of the risk factors only health knowledge (with regard to stool-related handwashing) and severity (with regard to food-related handwashing) were associated with behaviour and thus mediated the associations. The results can be interpreted in two ways: first, it is possible that additional BCTs had been applied, which were not evident based on the available content descriptions, and that these BCTs affected factors above and beyond the risk factors; second it is possible that the above mentioned BCTs had unexpected ancillary effects on additional factors.

In terms of research question 4, how strongly are the different intervention activities related with handwashing behaviour, of the 16 applied channels and activities, only three were significantly positively associated with stool- and food-related handwashing; radio spots, material distributions and information from neighbours or friends, with the latter being a positive side effect of the interventions, rather than a genuine intervention. In addition, stool-related handwashing was positively associated with radio programs and food-related handwashing with theatres and community clubs. These results are quite interesting inasmuch as these potentially effective channels and activities can all be categorised as mass communication (except information from neighbours and friends); these were expected to be less effective than interventions delivered in a group setting or in one-to-one-communication (cf. Part One, chapter 5). Further and rather unexpectedly, several channels and activities were *negatively* associated with handwashing; that means respondents who said to have experienced these interventions stated to wash their hands less often than those who stated not to have experienced these interventions. These were focus groups, stickers, posters, paintings and hygiene songs with regard to both, stool- and food-related handwashing. In addition, food-related handwashing was negatively associated with home visits and special hygiene days. There is evidence that at least part of these channels and activities were also less liked and were rated as less convincing and less trustworthy than the other channels. Possible explanations for these negative associations are presented in detail in Part Three. Finally, five channels and activities were not associated in either direction with stool- and food-related handwashing: these were megaphones, group discussions, hygiene training, cinema shows and quizzes.

To sum up, factors above and beyond risk factors mediated the channels' and activities' associations with handwashing. This is rather unexpected when considering the known interventions' content. Further, only few of the channels and activities were positively associated with behaviour while several were not associated with behaviour and some were negatively associated with behaviour. The results point out the importance of evaluating emergency handwashing interventions with regard to their effectiveness but also with regard to their underlying change processes.

1.3. Main findings Part Four, Chapter I: Effectiveness of theory-based and evidence-based population-tailored interventions

In study 4, two theory- and evidence-based population-tailored interventions were developed and tested in a full factorial design in four Borena kebeles in southern Ethiopia in comparison to a standard approach, an education intervention. In accordance to the RANAS approach (Mosler, 2012), this was done in three steps: first, the social-cognitive factors with the greatest intervention potential were specified (i.e. factors explaining handwashing in the targeted population, which are also largely changeable) by means of a cross-sectional, correlative design; second, BCTs which were expected to target exactly these factors were selected and combined within two interventions; third, these were tested in a nonrandomised controlled trial with regard to their effectiveness. In this third step, longitudinal and cross-sectional data were analysed.

In line with the first step research question 5 asked: which social-cognitive factors have the greatest intervention potential to promote handwashing? Cross-sectional data revealed that the predictors of stool- and food-related handwashing were severity, nurture, descriptive and injunctive norms, impediments and action control. Stool-related handwashing was also explained by disgust, motivational self-efficacy and commitment. Forgetting additionally predicted food-related handwashing. Changeability was assessed with regard to the population’s mean values in social-cognitive factors. Changeability was highest for descriptive and injunctive norms and volitional self-efficacy, which deviated most from their ideal values (which would be high descriptive and injunctive norms and high volitional self-efficacy). Combining the results, the greatest intervention potential was found for descriptive norm. Injunctive norm and impediments seemed also promising to target within interventions. In addition to these quantitative results, qualitative findings suggested that two further factors might be major obstacles to handwashing and should thus be addressed within interventions, namely forgetting and the current handwashing technique (or the lack of handwashing infrastructure).

In the second step, based on the RANAS approach (Mosler, 2012), three BCTs were selected, which were assumed to influence these factors; public commitment, facilitating resources and reminders. These were combined within two interventions; (1) a public-commitment intervention comprising public commitment and a reminder (a headscarf), and (2) an infrastructure-promotion intervention comprising facilitating resources (i.e. construction of handwashing stations) and a reminder (the handwashing station).

In the third step, research question 6 was addressed: are theory- and evidence-based population-tailored interventions more effective in changing handwashing than a standard intervention? The two theory- and evidence-based population-tailored interventions were tested in a full factorial design in combination with a standard education intervention, namely an f-diagram exercise, which was also applied in the control group. In terms of intervention outputs, the infrastructure-promotion was very successful; participants followed the invitation in large numbers and constructed handwashing stations for their families and recognised these as their designated place for handwashing. With regard to several outcome measures (i.e. proxy measures, self-reported handwashing and script-based covert report), education with infrastructure-promotion (with our without public commitment) was revealed to be most effective. Education with public commitment changed behaviour less effectively but it still performed better than the control condition, which comprised only education. Due to small sample sizes, observed handwashing could not be rigorously analysed. Still, frequencies were inspected. These indicated rather mixed results. Nevertheless, it was indicated that education with infrastructure-promotion performed best.

It should be mentioned that some protocol deviations were found with regard to the public commitment intervention's implementation. The deviations were most pronounced in the intervention group experiencing education with public commitment without infrastructure-promotion. This might explain why behaviour change was less positive in this intervention group than was expected for a group receiving a theory- and evidence-based population-tailored intervention. For more details see Part Four, Chapter I.

Altogether, study 4 suggested the following: first, building on theories to develop handwashing interventions is valuable as it provides ideas for intervention content above and beyond information and instruction provision; second, careful intervention monitoring in addition to providing training and intervention protocols is essential because intervention fidelity might critically affect an intervention's effectiveness; and third, theory- and evidence-based population-tailored interventions are more effective than standard approaches.

1.4. Main findings Part Four, Chapter II: The underlying processes of theory-based and evidence-based population-tailored interventions

The underlying change processes of the applied theory- and evidence-based population-tailored interventions were investigated in study 5 in comparison to the standard education intervention by means of mediation analyses of longitudinal data. The corresponding research question 7 asked: do the theory-based interventions change handwashing behaviour by affecting specific social-cognitive factors? The following factors were tested as mediators: descriptive and injunctive norms, motivational and volitional self-efficacy, impediments, forgetting and commitment. For education with infrastructure-promotion (with or without public commitment) the expected underlying change processes were largely confirmed. In more detail, the results suggested that the interventions changed handwashing by increasing social norms, motivational self-efficacy and commitment strength, and by decreasing impediments and forgetting. Only volitional self-efficacy did not mediate the interventions' effects, what contradicted our hypothesis. Education with public commitment (without infrastructure-promotion) affected handwashing by increasing social norms. Against expectations, commitment strength and forgetting did not mediate the intervention's effect. While the protocol deviations, which were mentioned before, might be responsible for this result, the reminding function of the commitment sign, a headscarf, might have failed because the participants seldom wore it, perhaps because they were not accustomed to it. For both interventions, no differences with regard to underlying processes were found in terms of stool- and food-related handwashing. In multiple mediation models only changes in social norms, commitment and forgetting but not changes in self-efficacy and impediments mediated the interventions' effects on change in handwashing. It is credible that the former variables are more behaviour-proximal and mediated not only the interventions effects but also the influence of the latter, potentially more behaviour-distal variables.

To sum up, when compared to a standard education intervention the theory- and evidence-based population-tailored interventions affected behaviour change largely according to the theoretically assumed change processes; in other words, behaviour changed as specific social-cognitive factors changed.

1.5. Main findings Part Five: Factors explaining over-reported handwashing

To get indications for alternative handwashing behaviour measures, study 6 explored the bias between self-reported and observed handwashing, i.e. the over-reporting in self-reported handwashing. Correlative and experimental designs were applied and data was collected cross-sectionally in Ethiopia. First, factors potentially explaining the bias were investigated and second, alternative measures were tested.

Research question 8 asked: are socially desirable responding and additional factors associated with over-reported handwashing? In terms of socially desirable responding, the following factors were all revealed to be positively associated with over-reporting in stool- and food-related handwashing: a socially desirable response style measured by the Marlow-Crown Social Desirability Scale, need for conformity, which is assumed to underlie this response style; and injunctive and descriptive norms, which stand for a question or interview topic's social sensitivity. Over-reported handwashing was also associated with factors assumed to cause over-reporting through encoding and recall processes: a regular daily routine and frequent task interruptions, both negatively associated with stool-related over-reporting and the latter also with food-related over-reporting, and a person's general estimation tendency (i.e. tendency to over-estimate), which was positively associated with both stool- and food-related over-reporting. With regard to frequent task interruptions, this result is against expectations (see Part Five for a potential explanation). Finally, two factors, which are thought to be involved in dissonance processes, were also associated with over-reporting: cognitive rationalisation, which was negatively associated with both, stool- and food related handwashing, and health knowledge, which was positively associated with handwashing but only with food-related.

Study 6 affirmed research question 9; additional factors indeed explained over-reporting beyond socially desirable responding. These additional factors were the factors potentially involved in encoding, recall and dissonance processes, which were discussed in the previous paragraph. Socially desirable responding and encoding, recall and dissonance factors explained both types of over-reporting well. However, explained variance was higher for over-reporting in stool- than food-related handwashing.

The last research question, number 10, asked: do alternative self-report measures decrease the bias in self-reported handwashing? None of the tested alternative wordings (i.e. loaded question wording, forgiving wording and a permissive question context), which have been suggested to mitigate socially desirable responding, influenced self-reported handwashing. A script-based covert recall, which was assumed to mitigate recall errors and socially desirable responding, yielded on average less over-reporting than standard self-reports. However, the variance in over-reporting was even higher. This means that the measure produced more accurate behaviour estimates on an aggregated level but not on the individual level.

In sum, further factors than socially desirable responding might cause over-reporting in self-reported handwashing. Alternative measures reducing the bias in self-reported behaviour are difficult to find; it is indicated that measures are in demand, which mitigate social desirability, encoding and recall errors in chorus.

Therewith, the summary of the main findings of this thesis is completed. In the next chapter, the implications for behaviour change theory and intervention research are discussed.

2. Implications for behaviour change theory and intervention research

In the general introduction of this thesis, three core requirements for the development of theory- and evidence-based population tailored interventions were stated, (1) a theoretical framework to explain handwashing behaviour change (theory-base); (2) a method to specify the key determinants to target in a specific population (population-tailoring); and (3) a taxonomy which links BCTs to specific determinants which they are known (or thought) to change (theory- and evidence-base). This chapter presents results and implications with regard to these three requirements and to the question, whether the application of theory- and evidence-based population tailored interventions is indicated.

2.1. Social-cognitive factors explaining handwashing

The five studies presented in Parts Two to four all provided insights into social-cognitive factors explaining handwashing behaviour (change). Two studies used data gained in Haiti (studies 1 and 3); three employed data from Ethiopia (studies 2, 4 and 5). Most applied cross-sectional, correlative designs (studies 1–4); one applied longitudinal data gained in a nonrandomised controlled trial (study 5). In the following, the findings from these studies are combined to reflect the relevance of social-cognitive factors in handwashing behaviour change. This is done in reference to the causal framework presented in Part One, chapter 3, that assumed that habitual handwashing is caused by a motivation process that leads to behaviour commitment, which is translated to behaviour through two processes, planning and control/preparation. Self-efficacy beliefs were expected to influence all three processes; impediments were thought to impinge upon the latter ones. It should be noted that a formal test of the framework, i.e. its causal structure, was not accomplished in the present thesis. Instead, factors were tested within multiple regression analyses only. These may misjudge the relevance of behaviour-distal factors whose influence is assumed to be mediated through more behaviour-proximal factors. Therefore, for the present purpose, correlational results and results from the earlier steps in the hierarchical regression analyses applied in studies 1 and 2 will also be consulted. Some indications regarding the factors causal structure were therewith provided and will be discussed.

Motivators

Risk factors. Vulnerability was consistently found to be associated with handwashing (studies 1−4) and explained handwashing in the first step of hierarchical regression analyses but not in later steps (studies 1–2). In line with the proposed causal framework, this suggests that vulnerability contributes to motivation formation but has no direct influence on behaviour. However, while it was expected that the higher the perceived vulnerability is, the more handwashing is performed, the association was negative. Interestingly, this is in in line with previous research with regard to handwashing (Devine et al., 2012) and with regard to various health behaviours, such as exercising or cancer screening (Norman et al., 2009). As outlined, these findings may be explained by reverse causality due to preventive action, meaning that people who do wash their hands – that is take preventive action – feel less vulnerable to diarrhoea than people who do not wash their hands – that is neglect a preventive action (Brewer, Weinstein, Cuite, & Herrington Jr, 2004; Norman et al., 2009). The feeling of vulnerability within the latter ones, however, might impact their future behaviour; in other words, they might start to take preventive actions because they feel vulnerable (Brewer et al., 2004). Due to the repeated findings of negative associations in previous research, it has been suggested to assess conditional vulnerability, that is perceived vulnerability when no preventive action would be taken (van der Velde, Hooykaas, & van der Pligt, 1996). For example, it could be asked ‘How likely is it that you will get diarrhoea, if you do not wash your hands with soap’. Such a measure should be considered in future research on handwashing behaviour to further investigate the influence of perceived vulnerability on handwashing behaviour.

In contrast, severity was positively associated with handwashing but only in Ethiopia, where it was also a strong predictor of handwashing (studies 1–4). The importance of severity in Ethiopia is rather surprising because in previous research, it was not a crucial predictor of handwashing (e.g. Botta et al., 2008; Clayton & Griffith, 2008). Still, the result suggests that depending on the population, perceived severity might not only motivate people to wash their hands, what was proposed in the causal framework. Rather, severity might even increase behaviour directly, what would be in line with the HBM (Rosenstock, 1966).

Health (or factual) knowledge, which was only implicitly included in the causal framework, was associated with handwashing but only in Haiti (studies 1–4). There, it was a key predictor of stool-related handwashing. Against expectations and counterintuitively, the association was negative, i.e. the higher the knowledge of respondents, the less they stated they washed their hands. In previous research, factual knowledge emerged as a weak predictor of handwashing, but no negative associations are known (e.g. Biran et al., 2009; Curtis et al., 2009; Hoque et al., 1996; O'Boyle et al., 2001). The result is rather alarming given that current handwashing interventions often focus on knowledge provision. As outlined before, there are two explanations for this finding. First, it might reflect that for respondents with higher levels of knowledge, self-report of behaviour is more accurate as they are more aware of the indications and opportunities for handwashing. Alternatively, the negative association might also reflect participants' abandonment of preventive actions. Diarrhoea is transmitted through several paths; handwashing neglect is only one potential cause and handwashing compliance is only one preventive measure. Knowledge was measured by asking for the causes and effects of diarrhoea and its preventive measures. High knowledge might thus reflect that respondents are more aware of the multiple causes and multiple preventive measures, which have to be taken. However, the respondents might not feel capable to actually engage in all these preventive actions and thus abandon the efforts. This latter interpretation is in line with research showing that fear (which might be aroused by relevant health knowledge) results only in protective behaviour when there is confidence in the own ability to perform the protective behaviour (i.e. self-efficacy; see Bartholomew et al., 2006). The association between health knowledge and handwashing behaviour should be further investigated; thereby, it should be controlled for self-efficacy beliefs with regard to all preventive measures.

Instrumental and affective beliefs. Altogether, instrumental and affective beliefs were consistently associated with handwashing (studies 1–4), they explained behaviour in the earlier steps of hierarchical regression analyses (studies 1–2), and partly emerged as key predictors of handwashing, such as nurture or disgust (studies 1, 2 and 4) or attractiveness or smell of soap (study 3). This indicates that a behaviour's pros and cons and related emotional reactions might contribute not only to motivation formation, what would be in line with the proposed causal framework. Instead, they might additionally have a direct influence on behaviour. The results are in line with previous findings related to handwashing, in which attitudes emerged not only as predictors of intention but also of behaviour (e.g. Aunger et al., 2010; Clayton & Griffith, 2008; Curtis et al., 2009; Jenner et al., 2006; Whitby et al., 2006; Yardley et al., 2011). It also corresponds to SCT (Bandura, 1977, 2004), which assumes that outcome expectations affect behaviour indirectly and directly.

Descriptive and injunctive norms. Social norms not only predicted handwashing behaviour in Haiti and Ethiopia (studies 1–4); they were also found to be key predictors of behaviour change in Ethiopia and mediated the theory- and evidence-based population-tailored interventions' effects (study 5). The results are in line with previous research on handwashing predictors (e.g. Clayton & Griffith, 2008; Curtis et al., 2009; Devine et al., 2012; Whitby et al., 2006; Yardley et al., 2011; but see Jenner et al., 2006). Further, they indicate that social norms are not only behaviour motivators, as was assumed in the causal framework, but that they directly influence behaviour, which is in line with SCT (Bandura, 1977, 2004).

It should be noted that social norms were also strong predictors of over-reported handwashing (study 6), probably due to socially desirable responding inasmuch as social norms are thought to reflect an interview theme's social sensitivity (Tourangeau & Yan, 2007). In other words, the amount of variance that social norms explain in self-reported handwashing comprises not only the amount of explained variance in 'actual' handwashing but also the amount of explained variance in over-reported handwashing. That is, the found association between social norms and self-reported handwashing is assumed to over-estimate the actual association.

Commitment

Commitment, which was considered in the causal framework instead of intention, was consistently associated with handwashing in Haiti and Ethiopia (studies 1–4). Also, it predicted behaviour change in Ethiopia and mediated the theory- and evidence-based population-tailored interventions' effects (study 5). In contrast to the causal framework, which assumed that commitment affects behaviour only indirectly, commitment seems to affect behaviour also directly. This is in line with TPB (Ajzen, 1991) and SCT (Bandura, 1977, 2004), which consider the paralleling concepts of intention and goal formation, respectively. The importance of commitment in explaining behaviour is also in line with the MPMHD (Tobias, 2009) and with previous research on water consumption (Alexandra Claudia Huber & Mosler, 2013; Inauen et al., 2014).

Planning

Action planning was only investigated in Ethiopia and only with a measure for the 'where'-component of the action plan, namely whether households have a designated place and facility for handwashing, which was rarely the case. No association with handwashing was found (study 4). As action plans and implementation intentions were found to be key determinants of goal attainment with regard to other health behaviours (Gollwitzer & Sheeran, 2006; Sutton, 2009), future research should investigate action plans with regard to handwashing in more depth by looking not only at the 'where'- but also at the 'when'- and 'how'-components.

Coping planning explained handwashing behaviour in Haiti and Ethiopia (studies 1–4). This is in line with previous research on physical exercise (Sniehotta, Schwarzer, et al., 2005). The results suggest that coping plans have not only an indirect influence on behaviour, as was suggested in the causal framework, but also a direct influence. This is in line with the HAPA (Schwarzer, 2008).

Preparatory behaviour planning was neither explored in Haiti nor in Ethiopia. However, it was targeted by means of the maintenance planning within the theory- and evidence-based population-tailored interventions in Ethiopia (study 4). Against expectations, the sub-intervention did neither affect the presence of soap or water at the handwashing station (i.e. the preparatory behaviour), nor did it affect behaviour. However, based on the results one cannot conclude whether preparatory behaviour planning is irrelevant or whether the planning intervention was not effective in fostering preparatory behaviour planning. The relevance of preparatory behaviour planning should be investigated in more depth in future studies.

Control and preparation

Forgetting explained handwashing behaviour in Haiti and Ethiopia (studies 1–4), predicted behaviour change in Ethiopia and mediated the theory- and evidence-based population-tailored interventions' effects (study 5). The results are in line with previous research on handwashing (Curtis et al., 2009; Pessoa-Silva et al., 2005) and indicate a direct influence of forgetting on behaviour, which corresponds to the causal framework and to the MPMHD (Tobias, 2009).

Action control was only investigated in Ethiopia. In line with previous research on physical exercise (Sniehotta et al., 2006; Sniehotta, Scholz, et al., 2005) it explained handwashing behaviour (study 4). The result suggests a direct influence on behaviour, which corresponds to the causal framework and the HAPA (Schwarzer, 1992).

In the presented studies, *preparatory behaviours* were not investigated as a behavioural predictor. However, one preparatory behaviour was targeted within the theory- and evidence-based population-tailored interventions, namely the construction of a handwashing facility. The intervention successfully influenced behaviour (study 5). This parallels research on condom use and physical activity, for which preparatory behaviours have been found to be key predictors (Bryan et al., 2002; Koring et al., 2013; Sheeran et al., 1999). Preparatory behaviours should be investigated in more depth in future research, especially with regard to the supply of water and soap at the handwashing facility.

Self-efficacy

Motivational and *volitional self-efficacy* were consistently associated with handwashing in Haiti and Ethiopia (studies 1–4). However, only motivational but not volitional self-efficacy predicted behaviour (change) and mediated the theory- and evidence-based population-tailored interventions' effects in Ethiopia (studies 1–5). In terms of motivational self-efficacy, the results correspond to previous research on handwashing behaviour (e.g. Clayton & Griffith, 2008; Jenner et al., 2006; Whitby et al., 2006; but see also Yardley et al., 2001; O'Boyle et al., 2001). Further, the results indicate that motivational self-efficacy has not only an indirect effect on behaviour (change), as was expected in the causal framework, but also a direct effect, which is in line with TPB (Ajzen, 1991) and SCT (Bandura, 1977, 2004). With regard to volitional self-efficacy, the results suggest that it has no direct influence on behaviour, which is in line with the causal framework. However, the finding that motivational but not volitional self-efficacy seems to directly predict behaviour contradicts the assumption that volitional self-efficacy is a more behaviour-proximal factor than motivational self-efficacy (cf. Schwarzer, 2008). Volitional self-efficacy has not been investigated with regard to handwashing behaviour before. More research is necessary to explore the factor's influence on behaviour.

Impediments

Perceived impediments explained handwashing in Haiti and Ethiopia (studies 1–4), predicted behaviour change in Ethiopia and mediated the theory- and evidence-based population-tailored interventions' effects in Ethiopia (study 5). The results are in line with previous research on handwashing (Affleck & Pelto, 2012; Curtis et al., 2009; Devine & Koita, 2010; Luby, Halder, et al., 2009) and suggest that perceived impediments affect behaviour directly. While this was not assumed in the causal framework, it is in line with HAPA (Schwarzer, 1992). *Actual impediments* were not investigated in this thesis although, according to the causal framework, they are assumed to have a crucial role in handwashing adoption. Future research should investigate actual impediments by applying proxy measures such as location of handwashing facilities, available amount of water per person per day, amount of time it takes to fetch water from the water source, amount of time it takes to fetch the soap for handwashing etc.

Causal structure

For several factors, which were assumed to affect behaviour only indirectly, the results suggested a direct influence on behaviour (e.g. motivators or motivational self-efficacy). This might be explained in two ways. First, of the direct behaviour predictors only forgetting was considered in all studies; action control was only considered in Ethiopia, none of the studies included preparatory behaviours. It is possible that (a part of) the found direct influences of more behaviour-distal factors would disappear by including all the direct predictors – as these are expected to mediate the influences of behaviour-distal factors – and that explained variance would increase. This should be investigated in future research.

Second, self-reported behaviour might rather reflect a behaviour intention than actual behaviour. That is, for behaviour intention direct influences from motivators and motivational self-efficacy would be expected. Behaviour intention would further be expected to influence latter factors in the causal chain (e.g. coping planning), which would as well explain the found associations with these variables. Behaviour intention was not considered in the present thesis but was replaced by commitment. This second interpretation is somewhat qualified by the result that commitment – which is assumed to parallel the concept of intention (Ajzen, 1985; Bagozzi, 1992) – and behaviour did correlate but not excessively. Still, it might be informative to investigate intention, commitment, self-reported and observed behaviour in future research to get insights on their relationship and on the actual meaning of self-reported handwashing behaviour. Ideally, this would be done by considering the remaining social-cognitive factors as predictors. Further, the outlined causal framework should be formally tested as only this can shed light on the factors' relationship.

Summary and conclusions

Taken together, the present thesis revealed the following social-cognitive factors as the most important predictors of handwashing behaviour (change) in Haiti and Ethiopia: the affective belief disgust, descriptive and injunctive norms, commitment, motivational self-efficacy, coping planning, forgetting and perceived impediments. In other words, people stated to wash their hands more often when they thought (1) that not washing hands is disgusting; (2) that others wash their hands; (3) that others expect them to wash their hands; (4) that they are highly committed to handwashing; (5) that they are able to always wash their hands at key times; (6) that they have plans to cope with impediments or barriers; (7) that they rarely forget to wash hands; and (8) that there are few impediments to handwashing. What is more, six of these factors were successfully targeted within theory- and evidence-based population-tailored interventions and mediated the interventions' effects on behaviour, namely descriptive and injunctive norms, commitment, motivational self-efficacy, forgetting and perceived impediments.

Of the SCMs discussed in Part One, chapter 3, the HAPA (Schwarzer, 1992, 2008) is the one which includes the most of these factors. However, the HAPA does not consider forgetting. The present thesis, though, suggests that it is worthwhile to take forgetting into account. Further, the HAPA does not distinguish between instrumental and affective beliefs and norm factors. Rather, these are subsumed as outcome expectations. However, it seems useful to consider these factors separately inasmuch as different intervention content is indicated to target instrumental or affective beliefs or social norms (see also below). The multi-theoretical approach RANAS (Mosler, 2012), on the other hand, considers these factors separately and takes into account forgetting, but it does not include perceived impediments. Neither the HAPA (Schwarzer, 1992, 2008), nor the RANAS (Mosler, 2012) approach consider preparatory behaviours, which might be relevant for regular handwashing adoption.

Altogether, the results on social-cognitive predictors of handwashing support the assumption that multiple theories should be considered when planning theory-based behaviour interventions because all SCMs discussed in Part One, chapter 3 missed relevant predictors of handwashing behaviour (cf. Abraham, 2012).

The use of a theory-base to develop interventions is of course only justified when such interventions are more effective than a standard approach. This is discussed in the following based on this thesis' results.

2.2. The effectiveness of theory- and evidence-based population-tailored interventions

Because theories suggest many potential factors to target, usually it is necessary to select specific factors to intervene on. In this thesis, to take into account the particularities of the target population, population-tailored interventions were developed in accordance to the RANAS approach (Mosler, 2012, cf. Aboud & Singla, 2012; Abraham, 2012; Bartholomew et al., 2006). That is, those factors were selected to intervene on, which seemed most relevant with regard to handwashing in the target population. Further, it was attempted to apply only evidence-based interventions, i.e. interventions whose effectiveness was verified in previous research. However, as the evidence-base with regard to handwashing interventions is limited to a small number of BCTs, evidence with regard to other behaviours had also to be considered.

As discussed earlier, study 4 (Part Four, Chapter I) revealed that theory- and evidence-based population-tailored handwashing interventions were more effective in changing behaviour than a standard education approach. This is in line with previous research showing that theory-based health behaviour interventions are more effective in changing behaviour than those lacking a theoretical underpinning (e.g. Taylor et al., 2011; Webb et al., 2010; but see also Prestwich et al., 2013). Furthermore, the effectiveness of population-tailored interventions has also been affirmed in previous research on water consumption (Inauen & Mosler, 2013; but see also Mikolajczak, 2008). In sum, it is thus possible, to conclude that interventions, to be effective, should not only be based on theory and evidence but also tailored to the population.

However, both the study on water consumption and the present research have not tested the superiority of population-tailored interventions over merely theory-based interventions. (Neither was the superiority of a merely theory-based intervention over a standard approach tested within these studies.) A more rigorous test of the effectiveness of population-tailored interventions would thus need a comparison to a merely theory-based intervention. Ideally, three different intervention conditions would be applied: (1) a control condition receiving only a standard approach; (2) a theory-based condition receiving a theory-based intervention along with the standard approach; and (3) a population-tailored condition receiving a theory-based population-tailored intervention along with the standard approach (cf. Williams, 2010). Strictly speaking, population-tailored interventions would only be indicated if they proved to be the most successful interventions within the outlined research design.

Further, interventions should not only be judged based on their effectiveness but also based on their cost efficiency (Abraham, 2008; Weinstein et al., 1998). The development of population-tailored interventions is costlier than the development of theory-based interventions or the application of standard approaches because it implies a thorough survey of the behaviour determinants. It may be argued that population-tailored interventions are only advisable when their increased effectiveness compared to theory-based or standard interventions outweighs the additional costs due to the survey. Of course, any costs that arise for theory-based or standard interventions due to necessary elicitation research should also be taken into account. Cost efficiency should be taken into account in subsequent studies.

It should be noted that the use of a population-tailored intervention is only appropriate when there is sufficient homogeneity within the target population with regard to behavioural predictors (cf. Kreuter, Lukwago, Bucholtz, Clark, & Sanders-Thompson, 2003). If this is not the case, one common approach for all members might not be justified. Instead, it might be necessary to apply different interventions for specific subgroups (e.g. women versus men; urban versus peri-urban etc.; cf. Tobias, Brügger, & Mosler, 2009; Weinstein et al., 1998) or even to address each individual separately, for example by means of menu-based interventions (Abraham, 2008). In menu-based interventions, for each participant an individual intervention package is compiled based on the participant's action readiness according to multiple social-cognitive determinants (Abraham, 2008). Such an approach seems easily implementable[31] in web-based interventions but more difficult to apply through traditional communication channels, such as home visits, community meetings or radios. Web access is still limited in developing countries; therefore, menu-based interventions seem not (yet) suitable to promote handwashing in developing countries (however, for a sample study of a simple menu-based WASH intervention in a developing country, see Alexandra C. Huber, Tobias, & Mosler, 2014).

[31] However, a menu-based intervention approach may need to cover a large number of different BCTs. This is of course more effortful than a simple intervention based on a few BCTs.

To conclude, population-tailored interventions seem promising to promote behaviour. However, additional research is needed to verify their efficacy compared to merely theory-based interventions. Further, their cost efficiency should be considered.

2.3. BCTs or the underlying processes of change

The basic idea of theory-based interventions is to change behaviour by modifying its predictors. While SCMs provide information on behavioural predictors, we also need information on techniques to change these predictors. The evidence-base with regard to which techniques change which social-cognitive factors and thus behaviour, is still limited (Lippke & Ziegelmann, 2008). According research was conducted in the present thesis.

As outlined before, study 5 (Part Four, Chapter II) largely confirmed the expected underlying change processes of the applied theory- and evidence-based population-tailored interventions. At that, the processes were rigorously tested by applying a control group with a standard education intervention instead of a no-contact or contact-only control group (Williams, 2010). To test the underlying change processes even more thoroughly, instead of including only the social-cognitive factors as mediators according to which the interventions were developed, additional social-cognitive factors might be included. With that, unexpected ancillary effects could be detected (as might have been the case in study 3 of this thesis). Further, for some interventions, the inclusion of additional mediators might help to disqualify courtesy bias[32] as an explanation for the interventions' effects. While it is credible that respondents favourably over- or under-report all social-cognitive factors (and behaviour) due to a courtesy bias, it is less credible that they systematically over- or under-report specific social-cognitive factors in conformity to the intervention's content – unless the social-cognitive factors targeted by the intervention are immediately obvious. In the present case, the assumed underlying change processes were not immediately obvious (e.g. self-efficacy or forgetting with regard to the handwashing station construction); therefore the inclusion of additional factors might have been useful. The question is of course, which social-cognitive factors should be additionally selected for testing. While this is easily answered when a specific SCM was applied for intervention development – namely all remaining behaviour predictors considered in the model – the answer is not evident when a multi-theoretical approach was applied.

[32] Courtesy bias is a response bias due to respondents providing information that they think the interviewer wants to hear (R. E. Mitchell, 1965).

An increase in the evidence-base regarding interventions' underlying change processes, but also with regard to their effectiveness, is only possible, when intervention evaluations adequately describe the intervention's content (cf. Abraham & Michie, 2008). Several taxonomies with standardised definitions of interventions' content (i.e. BCTs) have been suggested to increase the standardisation of intervention descriptions in evaluations (e.g. Abraham, 2012; Michie et al., 2013). However, it may be questioned whether the use of these descriptions allow "to faithfully replicate effective interventions" (Abraham & Michie, 2008, p. 379). With regard to handwashing, for example, BCT-2, to describe likely material consequences of behaviour (Abraham, 2012), might stand for descriptions of health outcomes (prevention of diarrhoea), descriptions of benefits (e.g. increase attractiveness or behaviour familiarisation of the children) or costs (e.g. increased spending for soap or water). While the description of some of these consequences may effectively change behaviour, others may be ineffective. In other words, knowing that an intervention, which described likely material consequences of behaviour, was effective may not help to faithfully replicate the intervention as one does not know which consequences were described and thus effectively changed behaviour. Similarly, in study 3 the available information on the INGO affiliates' interventions suggested that mainly risk factors and response efficacy were targeted. However, it is possible that the interventions, although they were said to have provided information on behaviour-health links (e.g. explaining the chain of contamination or good and bad behaviour), included messages such as 'when you wash your hands, your child will be healthier, thus grow well and eventually be more successful in life', which would rather target nurture. Information on such specific differences in intervention content seems not only essential for evidence-based programming but also with regard to meta-analyses, which are intended to expand the evidence-base.

Related to this is the above remark that intervention development might profit when one considers instrumental and affective beliefs and social norms separately instead of including only a broader concept, such as outcome expectations (cf. Bandura, 2004; Schwarzer, 2008). When underlying processes of change are tested (i.e. within mediation analyses), these different concepts should also be separately considered; testing only the broader concept (i.e. outcome expectations) might obliterate changes in some of the more specific concepts.

Altogether, the present thesis successfully tested the underlying change processes of theory- and evidence-based population-tailored interventions. Such tests might be strengthened by considering concurrent social-cognitive factors as mediators. Further, successful applications of evidence-based interventions require detailed descriptions of the evaluated intervention's content. While the proposed BCT taxonomies (e.g. Abraham, 2012; Michie et al., 2013) provide standardised definitions, which are essential prerequisites for standardised intervention descriptions, more detailed information seems necessary to allow evidence-based programming. In line with this, more and more scientific journals offer the possibility to publish online additional information, such as detailed intervention descriptions, along with the scientific article.

2.4. Further factors potentially affecting an intervention's effectiveness

Whether an intervention is effective depends not only on its content (i.e. the applied BCTs) or whether it was tailored to a specific group or to individuals but also on further factors, including an intervention's fidelity or the applied communication channel or mode of delivery (Abraham & Michie, 2008).

Intervention fidelity

As mentioned, one of the theory- and evidence-based population-tailored interventions, i.e. public commitment intervention, changed behaviour less effectively than expected and did not change all of the assumed social-cognitive factors. As outlined, several reasons may explain this result. First, it might be that this result simply reflects that the intervention is indeed less effective than was assumed. Second, it is possible that the applied public commitment sign, a head scarf, was not able to bring about the expected changes because participants seldom wore it, perhaps because they were not accustomed to it. (This might have been realized before intervention implementation, if the head scarf had been carefully pretested. However, due to time limitations, this was not comprehensively done.) Finally, it is possible that intervention fidelity was not consistently ensured and thus impaired the intervention's effectiveness. Indeed, with regard to the public commitment intervention, some protocol deviations were noted.

While it is not possible to identify which of these explanations is correct, the result emphasises the importance of guaranteeing protocol conformity during intervention implementation. Further, it stresses the importance of considering intervention fidelity in intervention evaluations – including meta-analyses – no matter whether they assess interventions' effectiveness or their underlying processes (cf. Abraham & Michie, 2008; Davidson et al., 2003; Prestwich et al., 2014).

Communication channels

As mentioned in Part One, chapter 5, the effectiveness of a BCT is expected to be contingent on the mode of delivery, i.e. the communication channel with which it is conveyed (cf. Abraham & Michie, 2008; Tamas, Tobias, & Mosler, 2009). It was assumed that one-to-one-communication is more effective than a group setting and that mass media is least effective. While the theory- and evidence-based population-tailored interventions tested in Part Four of this thesis were implemented only through one channel (i.e. group setting), in Part Three (study 3) different communication channels were investigated with regard to the handwashing interventions in Haiti. Against expectations, mass communication channel (e.g. radio spots and programs) were among the channels being most positively associated with handwashing, while a one-to-one-communication channel (i.e. home visits) was partly negatively associated with handwashing. However, the channels investigated in Part Three did not deliver only one single BCT (or a single combination of BCTs) and the applied BCTs per channel were not determinable. Therefore, it was not possible to identify whether a channel was positively or negatively associated with behaviour in itself or due to the delivered BCTs. Two other studies on handwashing are known which also investigated the impact of different communication channels (Pinfold, 1999; Scott et al., 2008). In the study by Pinfold (1999) intervention content and communication channels were also not clearly separable. The study by Scott et al. (2008) at least delivered one common message through different channels; still, the interventions which were actually applied in different channels implied different BCTs.

Altogether, future research should investigate whether a specific BCT or a specific combination of BCTs yields similar effects when delivered through different channels. Therein, it should be taken into account that a communication channel itself may constitute a BCT. For example might BCT-2, describe likely material consequences of behaviour (Abraham, 2012), be applied with the exact same wording within a home visit, a radio spot and a poster sent to a household. While the home visit and the radio spot would indeed deliver only BCT-2, the poster, when the receivers hang it up at home, might in addition serve as a reminder (BCT-37; Abraham, 2012), which might influence the channel's effectiveness.

Knowledge about whether and in how far different communication channels influence a BCT(-combination)'s effectiveness is highly relevant for practice as different communication channels have a different reach, with mass media having the highest reach and one-to-one communication the lowest. In fact, when assessing the effectiveness of BCTs delivered within different communication channels, their reach should explicitly be taken into account. If a BCT delivered by a radio spot were found to change behaviour only in 10% of the beneficiaries but reached 2000 people (200 successful changes), its impact would still be higher than the same BCT delivered by home visits which changed behaviour in 40% of the beneficiaries but reached only 300 people (120 successful changes; cf. Lippke & Ziegelmann, 2008).

To conclude, intervention fidelity and the applied communication channel might also affect an intervention's effectiveness. Therefore, these factors should be considered in intervention evaluations along with the intervention's content (i.e. BCTs; cf. Abraham & Michie, 2008; Davidson et al., 2003).

Therewith, the reflections with regard to behaviour change theory and intervention research are concluded. The focus of this thesis, however, was neither on theory development nor on intervention research as such. Instead, the main aim was rather a practical one, namely to evaluate handwashing interventions in emergency aid and to test whether interventions in DEA might be improved by being theory- and evidence-based and tailored to the targeted population. Accordingly, the thesis findings have relevant implications for handwashing interventions in DEA. These are discussed in the following.

3. Implications for handwashing interventions in DEA and remaining challenges

3.1. Intervention content: BCTs for the promotion of handwashing

As outlined in Part One of this thesis, to date handwashing interventions in developing countries focus only on a few different BCTs and the most frequently applied BCT is to provide information about behaviour-health links (BCT-1; Abraham, 2012). Health knowledge, vulnerability and severity, which are assumed to be predominantly affected by this BCT along with response efficacy, emerged to be inconsistently associated with handwashing behaviour in Haiti and Ethiopia (see chapter 2 of this Part) and other developing countries (e.g. Biran et al., 2009; Curtis et al., 2009; Devine et al., 2012). Further, a standard education intervention in DEA that explicitly focuses on the explanation of behaviour-health links, the f-diagram exercise, was found to be ineffective with regard to changing handwashing behaviour (see Part Four of this thesis). While it is possible that targeting risk factors may be helpful with regard to early stages of behaviour adoption (e.g. bringing people from pre-contemplation to contemplation; cf. Prochaska & DiClemente, 1983) the strong focus of today's interventions in DEA on providing information about behaviour-health links is not recommendable. Instead, the interventions should target additional factors. As mentioned, information on potentially relevant behaviour predictors can be found in SCMs. Therefore, it is advised, that practitioners in DEA develop handwashing interventions not only based on the activities and tools proposed by PHAST (Simpson-Hebert et al., 1997), the Global WASH Cluster (2009b, 2011) and the WHO (Odhiambo & Reed, 2013) along with intuition, previous experience and best practice (A. Andres, Oxfam Great Britain, personal communication, June 25, 2014; Vujcic et al., 2014) but that they first and foremost consult multiple SCMs (cf. Aboud & Singla, 2012).

More specific suggestions on recommended handwashing content are derived from this thesis' results with regard to the social-cognitive factors. Eight factors consistently predicted handwashing in Haiti and Ethiopia and might thus be targeted in interventions: the affective belief disgust, descriptive and injunctive norms, commitment, motivational self-efficacy, coping planning, forgetting and perceived impediments (see chapter 2 of this Part). Table 40 provides example BCTs which might be applied to target these factors along with more specific descriptions for intervention content.

Some of these BCTs were tested within this thesis (Part Four), namely public commitment, promotion of facilitating resources and reminders. While the first two BCTs were explicitly approached, reminders were more implicitly targeted as part of the other two. Facilitating resources, i.e. the promotion of handwashing station construction, effectively changed behaviour and is thus highly recommended for handwashing interventions in DEA. Public commitment, however, yielded mixed results and should thus be further investigated before its application can be fully endorsed. The remaining BCTs in Table 40 are recommended to be applied in handwashing interventions in DEA; however, these interventions should be thoroughly evaluated (as should every intervention so as to establish a broad evidence-base to allow evidence-based practice; see below).

Table 40. Overview on potential social-cognitive factors to target in handwashing interventions in DEA along with linked BCTs

SC factors	BCTs	Descriptions
Affective belief – disgust	BCT-6: describe likely emotional or affective consequences of behaviour neglect	Attach aversion (i.e. feeling of disgust) to the unhealthy behaviour of not washing hands: • Make the contamination of hands with faecal material visible (e.g. with Glo Germ). • Explicitly point out, that not washing hands with soap means eating faeces.
Descriptive norms	BCT-9: provide information about others' behaviour	Provide information (correct or devised) about the high handwashing frequency of important others (e.g. community elders, community or religious leaders), other communities, other regions. Identify and publicly announce 'model-households' which show high handwashing frequency.
	Public commitment	Ask people to publicly commit, if possible important others (e.g. community elders, community or religious leaders) should commit first, and present committed people with a commitment sign.
Injunctive norms	BCT-10: provide information about others' approval of the beneficiary's behaviour	Provide information about others, if possible important others (e.g. community elders, community or religious leaders), approval of high handwashing frequency and disapproval of low frequencies.
	Public commitment	Ask people to publicly commit, if possible, important others (e.g. community elders, community or religious leaders) should commit first, and present committed people with a commitment sign.
Commitment	BCT-31: agree a written behavioural contract	Make a contract with the beneficiaries where they oblige themselves to handwashing.
	Public commitment	Ask people to publicly commit and present committed people with a commitment sign.
Motivational SE	BCT-16: provide instructions	Explain how to wash hands.
	BCT-20: prompt practice	Let people wash their hands.
	Provide or promote facilitating resources	Provide or promote the construction of handwashing stations to facilitate behaviour performance and thus allow mastery experience.
Coping planning	BCT-21: prompt barrier identification and planning	Motivate to and support in identifying barriers to regular handwashing and to develop detailed but realistic coping plans against them.

(continued)

Table 40 (continued). Overview on potential social-cognitive factors to target in handwashing interventions in DEA along with linked BCTs

SC factors	BCTs	Descriptions
Forgetting	BCT-36: prompt organisation of social support	Ask people to organise verbal social support, i.e. to remind to wash hands. For example children could observe and alert their mothers each time when they should wash their hands but don't do it.
	BCT-37: teach to use environmental cues or provide cues or prompt to install cues	Put or install handwashing stations at a clearly visible place, e.g. exit of latrines, next to the fire place.
		If no handwashing station is existent, water and soap can be put together in a visible place.
		Hang up reminders, e.g. posters, stickers.
Impediments	Provide or promote facilitating resources	Provide or promote the construction of handwashing stations to make water and soap readily available.
	BCT-36: prompt organisation of social support	Ask people to organise social help in form of material (e.g. soap or water) or verbal social support (e.g. remind to wash hands).
	BCT-21: prompt barrier identification and planning	Motivate to and support in identifying barriers to regular handwashing and to develop detailed but realistic coping plans against them.

Note. SC factors = Social-cognitive factors. Motivational SE = Motivational self-efficacy. BCTs according to Abraham (2012) and (Mosler, 2012).

The tested BCTs were not only based on theory and evidence but also tailored to the targeted population. The present thesis cannot identify whether the applied interventions were effective merely because they were theory-based or additionally because they were population-tailored. Still, instead of applying standard approaches in DEA, the content of handwashing interventions (i.e. BCTs) should be specified by taking into account the respective setting and audience through thorough elicitation research (cf. Aboud & Singla, 2012; Abraham, 2012; Bartholomew et al., 2006).

Further, it was revealed that it can be distinguished between stool- and food-related handwashing (see Part Two) and that these types of handwashing are partly explained by different social-cognitive factors (see Parts Two to Four). Therefore, practitioners could applydifferent BCTs to promote stool- and food-related handwashing. For example, forgetting was found to be more relevant with regard to food-related handwashing (Part One). Therefore, reminders could be applied that explicitly focus on handwashing before preparing food and eating instead of handwashing in general.

3.2. Population-tailoring – a challenge in DEA practice

As mentioned, the efficacy of behavioural interventions might be further increased by being tailored to the targeted population. However, population-tailoring might be challenging to apply in DEA; at least when employed as within this thesis, i.e. with an extensive baseline data collection and a comprehensive data analysis. That is, their usability in practice is uncertain (cf. Leventhal, Musumeci, & Contrada, 2007; Nicassio, Meyerowitz, & Kerns, 2004). Factors within DEA, which may impede population-tailoring are (1) the often limited time-frames of projects; (2) the necessity of quick response in emergency settings, particularly in emergencies with a rapid onset (e.g. earthquake or flood), when lives are immediately at stake (cf. Wisner et al., 2003); (3) limited funding for project evaluation or research; (4) limited capacity within organisations (while many MOs and INGOs have today a monitoring, evaluation and learning division, the workload caused by population-tailoring can be expected to exceed their capacity). To enable population-tailored interventions in DEA, the complexity of the survey would have to be reduced by simplified ready-to-go questionnaires and more basic analysis approaches (e.g. between-group mean comparisons instead of regression analysis). On the other hand, ready-to-go questionnaires bear the risk that the specific context is not taken into account – what directly contradicts the idea of population-tailoring – and important factors are thus missed. Therefore, the adaptation of a pre-prepared questionnaire to the specific situation based on formative research (e.g. focus groups, qualitative interviews) seems inevitable. Alternatively, aid agencies could rely entirely on formative research to gain insights into the specific population and context. However, this would have to be thoroughly conducted by means of detailed implementation or instruction protocols.

3.3. Intervention evaluation and process monitoring

As was mentioned, rigorous evaluations of handwashing interventions in DEA are rare, especially in an emergency context, for which to date an evidence-base is rarely existing (cf. Aboud & Singla, 2012; Vujcic et al., 2014). However, evaluations are essential, no matter whether standard approaches or theory-based or population-tailored interventions are applied; evaluations provide the necessary basis for evidence-based programming and thus lower the risk that ineffective interventions are adopted (cf. Abraham & Michie, 2008; Davidson et al., 2003; Nicassio et al., 2004).

The present thesis addressed the evaluation of emergency handwashing interventions. Yet, no rigorous evaluation was possible as only cross-sectional data and no control and intervention groups were available. Still, the results further emphasize the importance of rigorous evaluations of handwashing interventions in DEA. First, of the vast number of applied channels and activities, only few were positively associated with handwashing. Second, negative associations between intervention activities and handwashing behaviour indicated that some of the applied activities and communication channels might not only have been ineffective but even counter-effective. Therefore, the establishment of regular, rigorous evaluations of the effectiveness of handwashing interventions in DEA are strongly recommended. Further, it seems more advisable to apply only a few activities that were proven to be effective rather than a great number of activities with unknown effectiveness.

To contribute to an evidence-base, effectiveness evaluations in DEA have to be based at least on the following: (1) baseline and endline surveys measuring handwashing behaviour (i.e. the program outcome instead of its output) and (2) detailed intervention protocols describing the interventions content and their mode of delivery (for a more detailed desciption, also of additional requirements, see Des Jarlais et al., 2004). It should be noted that due to ethical concerns, the application of intervention and control groups within interventions in DEA is often not feasible, especially in an emergency context. Therefore, only a pre-post-design is suggested. This can be augmented by including a “natural” control group, i.e. people who have not received the intervention due to external circumstances (e.g. not available) or due to self-selection (not willing to participate).

Further, not only a thorough evaluation of handwashing interventions in DEA is indicated but also a careful process monitoring. As mentioned, the efficacy of one of the theory- and evidence-based population-tailored interventions, i.e. the public commitment intervention, is uncertain. There is evidence that protocol deviations might have impaired the intervention’s effectiveness. The occurrence of protocol deviations might be seen as rather surprising when considered that detailed intervention instructions were given and a thorough process monitoring through the implementing NGO was planned. However, in practice the monitoring was not rigorously carried out, amongst others due to shortages in means of transportation. Given that especially in an emergency setting lives depend on the effectiveness of the implemented interventions, the assurance of a thorough and rigorous process monitoring along with immediate corrective actions seems indispensable.

To conclude, instead of focusing on the provision of information about behaviour-health links (BCT-1; Abraham, 2012), handwashing interventions in DEA might increase their effectiveness by considering additional BCTs. Especially recommended is the application of the 11 BCTs presented in Table 40. Further, elicitation research should be applied to take into account the respective setting and audience when selecting an intervention’s content. To ensure that the applied interventions are effective (at least in the long run), careful process monitoring and regular, rigorous evaluations of the program outcomes are necessary.

Regular, rigorous evaluations in DEA, however, are only feasible when a valid and efficient behaviour measure is available. This is especially true for large-scale or minimally funded projects. The thesis implications with regard to the measurement of handwashing behaviour are presented in the following.

4. Implications for the measurement of handwashing behaviour: Further need of research

As discussed, none of the currently available handwashing behaviour measures are thought to be valid and efficient at the same time; e.g. observations are assumed to be valid but very cost-ineffective and self-reports very cost-effective but invalid (Biran et al., 2008; Curtis et al., 1993; Ram, 2013). The present thesis hoped to gain indications for alternative self-report measures by investigating factors explaining the bias between self-reported and observed handwashing behaviour. While Part Five provided some indications on factors explaining over-reported handwashing beyond socially desirable responding, no clear suggestions for how to improve self-report measures were given. Some of the biasing factors might be statistically controlled for; however, the controllable factors explained rather a small amount of the variance in over-reporting. The tested script-based covert recall seemed to reduce the response bias on an aggregated level but not on an individual level. Therefore, the measure cannot yet be recommended for use in evaluations. Further research is needed to optimise this measure but also to test the ability of additional techniques to increase response accuracy, such as the bogus pipeline procedure to lower socially desirable responding (cf. Tourangeau & Yan, 2007) or weekly recall diaries to reduce recall errors (Heeb & Gmel, 2005).

Also, it might be worth to investigate habit as a potential outcome measure. Not only may habitual handwashing be seen as the ultimate goal of handwashing interventions (cf. Lally & Gardner, 2011). What is more, habit measures might be less affected by response biases than behaviour measures. Especially socially desirable responding might be less pronounced because *habitual* handwashing can be assumed to be less normatively loaded than handwashing and recall errors might also be less influential.

Especially pressing with regard to handwashing measurement, however, seem studies that investigate the retest-reliability of observed and self-reported handwashing. Intervention evaluations that apply a pre-post-design have to be certain that observed changes are genuine and not caused by normal variation in behaviour performance. Therefore, the investigation of the behaviour measures' retest-reliability is essential. To my knowledge, to date, no study examined the retest-reliability of self-reported handwashing and only one study investigated the retest-reliability of observed handwashing, yielding low estimates of retest-reliability (Cousens et al., 1996).

Further, the applicability of an outcome measure might also depend on the evaluation's goal, i.e. whether an intervention's effectiveness or its underlying processes of change are of interest. For example, proxy measures are efficient and objective but do not provide individual data (whether their application still complies to the standard to measure behaviour in behavioural intervention evaluations may be questioned; cf. Michie & Johnston, 2012). However, when only the effectiveness of an intervention is of interest, changes on an aggregate level may be sufficient. With regard to observations, when evaluating an intervention's effectiveness, instead of combining observed key events (e.g. person A starts to prepare food) within a single observation session (e.g. observation of person A during three hours) to an overall estimate of the handwashing frequency (e.g. person A washed her hands in 30% of the key events), each observed event could be treated as a separate observation (i.e. as a separate case in the data file). Therewith, more cases would be available for analysis. (For example, when 50 persons were observed and on average four key events occurred, instead of 50 cases, 200 cases would be available for analysis). Hence, such an approach would allow to drastically reduce the sample size and thus the costs incurred for evaluation. To take into account that the cases are not independent of each other but nested within persons, data could be analysed by means of generalized estimating equations (cf. Hanley, Negassa, Edwardes, & Forrester, 2003) or by multilevel modelling. The behaviour changes investigated with such an approach would also reflect changes on an aggregate level but not changes on an individual level. However, when the evaluation interest is in the underlying processes of change, it is important to consider changes on an individual level. For that, the outlined approach seems not applicable as it is not possible to systematically assign cases at time 1 to cases at time 2. (For example, at T1 person A prepared food five times and handwashing occurred in three of these incidences, at T2 person A prepared food two times and washed her hands in one of these incidences; it is not clear how these incidences can be matched to investigate change over time).

Altogether, with regard to the measurement of handwashing behaviour, there is further need of research. As long as no valid and efficient measure for handwashing behaviour is found, regular and rigorous evaluations of handwashing interventions will be difficult to implement in DEA.

5. Strengths and limitations

This thesis provides the first in-depth, theory-based, quantitative analysis of social-cognitive determinants of handwashing in developing countries based on results from two different countries. Even more, to my knowledge, it considered handwashing determinants more comprehensively than any previous quantitative study in developing and developed countries by taking into account not only motivational but also volitional factors (e.g. coping planning or volitional self-efficacy). Therewith, it extends the understanding of handwashing behaviour considerably, which may help in improving the effectiveness of handwashing interventions in DEA through novel intervention content. This achievement is slightly qualified by the fact that data was collected only in the recovery phase of emergencies. Therefore, the findings cannot be unequivocally generalised to an emergency relief or development context. A further accomplishment is that the studies statistically distinguished between stool- and food-related handwashing behaviour and measured (a large part of) the social-cognitive factors separately for stool- and food-related handwashing. This approach is in line with the principle of compatibility, i.e. that only behaviour-specific attitudes can predict corresponding behaviours (Ajzen & Fishbein, 2000). It may be criticised that not all social-cognitive factors were measured separately. However, to keep the length of the interview acceptable this was unfeasible. In addition, it was revealed that stool- and food-related handwashing are partly explained by different factors, which might be relevant for intervention development (cf. Aunger et al., 2010).

With regard to handwashing interventions, to my knowledge, study 3 of this thesis is the first extensive evaluation of handwashing interventions in emergency aid. As it applied a cross-sectional correlative design, it provided only initial insights. Still, the findings point out the necessity of rigorous evaluations of handwashing interventions in emergency aid and may thus help to promote their implementation towards practitioners and donors. Further, theory-based handwashing interventions in developing countries are a rarity (e.g. Curtis et al., 2009; Luby et al., 2010; cf. Aboud & Singla, 2012). The present thesis not only developed and tested theory-based interventions; what is more, it formally tested the proposed change processes. To date, analyses of the underlying change processes of behaviour change interventions are only seldom accomplished. Therewith, the thesis not only constitutes the first study of this kind with regard to handwashing interventions; what is more, it contributes to a still limited evidence-base on the underlying change processes of behaviour change interventions (cf. Lippke & Ziegelmann, 2008). Further, while previous handwashing interventions have in some cases been developed based on qualitative formative research (e.g. Scott et al., 2008), the tested theory-based interventions were quantitatively tailored to the targeted population. Also with regard to other health behaviours, such an approach has only been rarely applied (e.g. Inauen & Mosler, 2013; Mikolajczak, 2008; Mikolajczak, Kok, & Hospers, 2008; cf. Bartholomew et al., 2006). While there is still need of research with regard to the superiority of such population-tailored over merely theory-based interventions, it is a promising approach and the present investigations supported its applicability. The studies' results with regard to handwashing interventions were not only shared with all collaborating partners. They were also presented at various panels of INGOs and NGOs and were in some cases, especially with regard to the directly collaborating INGOs, incorporated into subsequent interventions in DEA. Therewith, the thesis succeeded in disseminating its scientific findings to practitioners in DEA (cf. Nicassio et al., 2004).

Finally, the thesis provides the only study looking at social-cognitive factors explaining the bias between self-reported and observed behaviour. While the study did not provide definite implications on how to improve the measurement of self-reported handwashing, it may still inspire future research and therewith contribute to overcome a major obstacle to handwashing evaluations, i.e. the measurement of behaviour.

Altogether, the results of this thesis provide not only important implications with regard to the promotion of handwashing in DEA and the evaluation of handwashing interventions; it also contributes to behaviour change theory and intervention research in general. Nevertheless, there are also several limitations to this thesis, especially with regard to the applied study designs and the behaviour measurement. These and additional limitations are addressed in the following.

5.1. Study designs

The studies on social-cognitive determinants of handwashing behaviour applied cross-sectional designs (studies 1 and 2). From these, no conclusions on causality between social-cognitive factors and behaviour can be drawn. In Ethiopia, some of the social-cognitive determinants were also applied in the longitudinal study analysing the theory- and evidence-based population-tailored intervention; for these the found associations were largely confirmed. Still, a longitudinal investigation of the social-cognitive determinants of handwashing behaviour seems indicated, also because it might help to clarify some of the rather surprising findings, such as the found negative associations of health knowledge and vulnerability with handwashing behaviour.

Similarly, the evaluation of emergency handwashing interventions in Haiti, study 3, was based on a cross-sectional design. Further, no control group was existent and the numerous channels and activities were not applied in different intervention groups. Instead, beneficiaries experienced diverse combinations of activities and channels. Therefore, it is not possible to draw any conclusions about causality, that is, whether intervention effects or self-selection[33] are responsible for the found associations between channels and behaviours. Also interactive or additive effects between channels/activities were not possible to investigate due

[33] It is possible that people high in handwashing tended to participate more often in certain activities or tended to remember more often to have participated in certain activities.

to the sheer number of applied channels/activities. While interventions would ideally be evaluated by means of a (cluster) randomised controlled trial, due to ethical concerns such an approach is hardly practicable within an emergency setting. Also the conduction of a baseline survey, at least in the early stages of an acute emergency, may be unfeasible. Still, subsequent studies should try to evaluate emergency handwashing interventions by means of a pre-post-design applying a short questionnaire focusing only on behaviour assessment.

The theory- and evidence-based population-tailored interventions were not tested in a (cluster-)randomised controlled trial (studies 4 and 5). Instead, a nonrandomised controlled trial with pre-post-design was applied; interventions were assigned to clusters. A randomised controlled trial (i.e. allocation of interventions to households) was not feasible because the interventions were public (public commitment and handwashing stations constructed at publicly visible places) so that information contamination would have been risked. Because only four clusters (i.e. kebeles) were investigated, a cluster-randomised controlled trial was also not possible to apply. With the applied design, cluster effects (e.g. non-comparability of intervention groups at baseline) cannot be ruled out. To level this shortcoming the according analyses were controlled for baseline values. Nevertheless, the intervention effects should be replicated in subsequent studies by means of randomised design. If a randomised controlled trial is not feasible, to rule out cluster effects sufficient clusters (i.e. 50 clusters) should be investigated as to allow not only the application of a cluster-randomised controlled trial but also multilevel modelling (Maas & Hox, 2005). Further, to allow the investigation of interaction effects, the theory- and evidence-based population-tailored interventions were implemented in a full factorial design with two factors (i.e. two interventions). However, due to cumulated protocol deviations within one intervention condition, it seemed not advisable to study the interventions' effects in accordance with a full factorial design (i.e. test of the two factors and their interaction). Instead, intervention conditions were compared to the control group. Therewith, it was no longer possible to investigate for interaction effects between the two interventions. This should be addressed in future research. Finally, there was a long time lag (around 6 months) between the baseline survey and the implementation of the interventions. This was partly caused because population-tailored interventions were applied, that is they were developed according to the baseline results, which required time. In addition, organisational difficulties within the local NGO delayed the implementation considerably. Due to the time lag, it cannot be ruled out that changes caused by confounding variables (i.e. time) distorted the interventions effects. In subsequent studies, to control for these effects, an additional survey might be conducted immediately before intervention implementation.

5.2. Sample sizes

A further shortcoming of studies 4 and 5 is that due to an untimely termination of the baseline data collection, the control group had a very small sample size. This may have decreased the studies power to detect significant results. In retrospective, it might have been preferable to investigate only the three kebeles with adequate sample sizes and to refrain from the full factorial design.

On the contrary, in Haiti a rather large sample size was applied. Therewith, also effects with a small effect size, which may be criticised as negligible effects, reached significance. To avoid this, effects could have been tested by using a *p*-value of .01 instead of .05. Such an approach should be considered for subsequent studies.

5.3. Data measures

Most of the analyses presented in this thesis were based on self-reported and not on observed handwashing behaviour. In Haiti, household observations were not feasible due to security issues (i.e. a curfew made early departures impossible). While observations were planned in displacement camps, i.e. observation of handwashing after latrine usage along with structured interviews, these were made impossible by the fact that latrine usage was very infrequent. In Ethiopia, observational data were collected. However, at baseline due to time and budget constraints only a part of the households were observed. In combination with an untimely termination of data collection, the achieved sample size in the control group was too small to allow statistical analyses. The disadvantages of self-reported handwashing have been discussed in detail (see Part Five). Nevertheless, the presented results are valuable because there is evidence that self-reported handwashing is associated with important health outcomes, i.e. child diarrhoea, child diarrhoea mortality and cholera infection (Hutin et al., 2003; Luby, Halder, Huda, Unicomb, et al., 2011; Water Sanitation and Hygiene Research Group, 2012). Still, future studies should try to replicate the findings based on observed data. To increase the reliability of the observational data, several observation sessions would be preferable.

The projects constituting this thesis had very narrow time frames, especially with regard to the preparation of the baseline surveys. Therefore, the applied items were mainly adopted from previous studies of which two were on water consumption and only one on handwashing behaviour (Aunger et al., 2010; Alexandra Claudia Huber et al., 2012; Inauen et al., 2013). These items had to be adapted to the cultural contexts in Haiti and Ethiopia. Due to the short time frame, a formal test of the items' validity and reliability was not possible. This should be accomplished in subsequent studies by employing larger item pools and longitudinal data.

Further, due to the applied multi-theoretical approach, a great number of social-cognitive factors were measured. In addition, a large part of these was assessed separately with regard to stool- and food-related handwashing. To keep the length of the interview acceptable it was therefore unfeasible to apply multi-item scales for each factor. To assure the measures' validity nonetheless, the items were constructed according to the C-OAR-SE method (Rossiter, 2011). In line with this method, mainly single-item measures were applied. For these, the primary selection criterion was maximal content validity while taking into account the local context. To capture multidimensional concepts multi-item-measures were used, i.e. for each dimension one item was applied.

5.4. Over-fitting

A strength of this thesis is that it investigated a broad range of social-cognitive determinants of handwashing by applying a multi-theoretical approach, i.e. the RANAS approach (Mosler, 2012). A downside of testing many determinants within multiple regression analyses is the risk to fall into the trap of over-fitting, i.e. that unnecessary factors are considered (Hawkins, 2003). Whether a factor is necessary to predict an outcome cannot be identified based on an increase in explained variance because the inclusion of any additional factor increases the variance in the outcome as long as the factor is correlated with the outcome (cf. Lippke & Ziegelmann, 2008). Further, testing many factors might also increase the risk of biased estimates due to undetected and thus untested interaction effects between predictors. To avert the risk of over-fitting at least partly, studies 1, 2, 4 and 6 only included factors into multiple regression analyses, which were significantly (and substantially) correlated with the outcome. Subsequent studies, which are only interested in explaining handwashing behaviour, might opt to focus on a single SCM. However, to develop effective handwashing interventions a multi-theoretical approach, such as the RANAS approach (Mosler, 2012), seems most promising, even on cost of parsimony (cf. Abraham, 2012; Lippke & Ziegelmann, 2008).

5.5. Relationship between social-cognitive factors

The relationship between social-cognitive factors was acknowledged in Part One, chapter 3.3, by proposing a causal framework to explain handwashing behaviour. However, the causal structure was not tested within this thesis but (mainly cross-sectional) data was merely analysed by multiple regression analyses. Therewith, the importance of behaviour-distal factors, whose influence might be mediated through more behaviour-proximal factors, may have been underestimated. In other words, behaviour relevant factors may have been neglected within intervention development because the applied statistical method did not allow recognising their importance. To test the causal structure, ideally, longitudinal data should be applied and analysed by means of structural equation modelling. Such an approach is recommended for subsequent studies investigating the social-cognitive determinants of handwashing. However, for the population-tailoring of interventions (i.e. the selection of social-cognitive factors to intervene on according to baseline data), due to the time and monetary costs that arise by collecting longitudinal data, such an approach seems unfeasible. To overcome the potential neglect of important behaviour-distal factors in population-tailoring, instead of applying multiple regression analysis, factors to intervene on could be selected based on correlation analyses or between-group mean comparisons. It should be mentioned that one could argue that the potential restriction to behaviour-proximal factors within interventions is even preferable as these explain more variance in behaviour change than behaviour-distal factors (cf. Sutton, 2008). However, beneficiaries low in behaviour-distal factors (e.g. beneficiaries with behaviour impeding instrumental beliefs), whose action readiness is therefore small with regard to a behaviour, may not profit from interventions focusing only on behaviour-proximal factors (e.g. forgetting; cf. Abraham, 2012).

With regard to the causal framework, it should also be noted that not all social-cognitive factors considered in the framework were included within the studies. This is partly due to the fact that the projects’ narrow time frames did not allow thorough formative research. Therefore, for some factors their potential relevance with regard to handwashing was realised only in the course of the surveys (e.g. preparatory behaviours). These factors should be considered in subsequent studies, at least in those focusing on the development and test of handwashing interventions. Also, for subsequent studies, whether they explore handwashing predictors or test interventions, extensive formative research is recommended because it may provide important insights into the problem at hand (e.g. handwashing) in the specific context.

6. General conclusions

To contribute to the goal of developing effective handwashing interventions in DEA, the present thesis investigated the social-cognitive determinants of handwashing, developed and tested theory- and evidence-based population-tailored handwashing interventions and evaluated standard handwashing approaches in emergency aid. Further, a major challenge for handwashing intervention evaluations was explored, that is over-reporting in self-reported handwashing behaviour.

In two different samples, one in Haiti and one in Ethiopia, social-cognitive factors successfully explained handwashing behaviour. Particularly important were expectancies about others' handwashing behaviour, perceived social expectations with regard to one's own handwashing, feeling highly committed to handwashing, the confidence in one's ability to regularly wash one's hands, having plans how to cope with impediments, rarely to forget to wash one's hands and feeling seldom hindered in handwashing. To increase the effectiveness of handwashing interventions in DEA, it can be recommended to target these factors.

In Ethiopia, interventions developed to increase social norms, commitment and motivational self-efficacy, and to mitigate forgetting and impediments, changed behaviour more successfully than a standard education intervention alone. What is more, these social-cognitive factors were found to mediate the interventions' effects on behaviour change. With this, the thesis not only demonstrated that theory- and evidence-based population-tailored handwashing interventions can increase the effectiveness of a standard approach but also verified why this is the case. Of the tested interventions, especially the promotion of the construction of handwashing stations can be recommended to enhance regular handwashing.

Further, of the activities and channels applied in standard emergency handwashing interventions in Haiti only few were shown to be positively associated with handwashing behaviour, while several were not associated with behaviour and some were negatively associated with behaviour. This result points out the necessity to evaluate handwashing interventions in DEA – which is to date a rarity – to prevent the use of ineffective interventions.

Handwashing intervention evaluations require an appropriate behaviour measure. Thus far, such a measure is not available. The present thesis provided some indications on factors explaining over-reported handwashing beyond socially desirable responding. However, no clear suggestions for alternative self-report measures were possible to be drawn. Further research is needed to overcome this challenge to regular handwashing intervention evaluations, i.e. the lack of a valid and efficient behaviour measure.

To conclude, handwashing is an exceptionally difficult behaviour to promote, particularly in settings with a multitude of behavioural impediments (i.e. lack of handwashing infrastructure, distant water sources, lack of water etc.). The present thesis emphasises the importance of social-cognitive theories to increase the effectiveness of behaviour change interventions, and the necessity to evaluate interventions, to avoid the use of ineffective interventions. Hopefully, this will stimulate the adoption of theory- and evidence-based handwashing interventions in DEA to successfully promote handwashing and potentially reduce the burden of disease for millions of people.

References

Abdella, N., Tefera, M., Eredie, A., Landers, T., Malefia, Y., & Alene, K. (2014). Hand hygiene compliance and associated factors among health care providers in Gondar University Hospital, Gondar, North West Ethiopia. *BMC Public Health, 14*(1), 96. doi: 10.1186/1471-2458-14-96

Aboud, F. E., & Singla, D. R. (2012). Challenges to changing health behaviours in developing countries: A critical overview. *Social Science & Medicine, 75*(4), 589–594. doi: 10.1016/j.socscimed.2012.04.009

Abraham, C. (2008). Beyond stages of change: Multi-determinant continuum models of action readiness and menu-based interventions. *Applied Psychology: An International Review, 57*(1), 30–41. doi: 10.1111/j.1464-0597.2007.00320.x

Abraham, C. (2012). Mapping change mechanisms onto behaviour change techniques: A systematic approach to promoting behaviour change through text. In C. Abraham & M. Kools (Eds.), *Writing health communication: An evidence-based guide* (pp. 99–116). London, United Kingdom: SAGE Publications Ltd.

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health Psychology, 27*(3), 379–387. doi: 10.1037/0278-6133.27.3.379

Abraham, C., & Sheeran, P. (2009). The health belief model. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 28–80). Maidenhead, United Kingdom: Open University Press.

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology, 25*(3), 273–291. doi: 10.1016/j.jenvp.2005.08.002

Abu Mourad, T. A. (2006). The impact of an environmental health and awareness program on palestinian refugees of Nuseirat Camp: A one-year-after report. *Journal of Environmental Health Research, 5*(1).

Affleck, W., & Pelto, G. (2012). Caregivers' responses to an intervention to improve young child feeding behaviors in rural Bangladesh: A mixed method study of the facilitators and barriers to change. *Social Science & Medicine, 75*(4), 651–658. doi: 10.1016/j.socscimed.2012.03.030

Agha, S., & Rossem, R. v. (2002). Impact of mass media campaigns on intentions to use the female condom in Tanzania. *International Family Planning Perspectives, 28*(3), 151–158. doi: 10.2307/3088258

Aiello, A. E., Coulborn, R. M., Perez, V., & Larson, E. L. (2008). Effect of hand hygiene on infectious disease risk in the community setting: A meta-analysis. *American Journal of Public Health, 98*(8), 1372–1381. doi: 10.2105/AJPH.2007.124610

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckman (Eds.), *Action-control: From cognition to behavior* (pp. 11–39). Heidelberg, Germany: Springer-Verlag.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes, 50*(2), 179–211. doi: 10.1016/0749-5978(91)90020-T

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood-Cliff, NJ: Prentice-Hall.

Ajzen, I., & Fishbein, M. (2000). Attitudes and the attitude-behavior relation: Reasoned and automatic processes. *European Review of Social Psychology, 11*(1), 1–33. doi: 10.1080/14792779943000116

Al-Tawfiq, J. A., & Pittet, D. (2013). Improving hand hygiene compliance in healthcare settings using behavior change theories: Reflections. *Teaching and Learning in Medicine, 25*(4), 374–382. doi: 10.1080/10401334.2013.827575

Albarracin, D., Gillette, J. C., Earl, A. N., Glasman, L. R., Durantini, M. R., & Ho, M.-H. (2005). A Test of major assumptions about behavior change: A comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. *Psychological Bulletin, 131*(6), 856–897. doi: 10.1037/0033-2909.131.6.856

Alp, E., Ozturk, A., Guven, M., Celik, I., Doganay, M., & Voss, A. (2011). Importance of structured training programs and good role models in hand hygiene in developing countries. *Journal of Infection and Public Health, 4*(2), 80–90. doi: 10.1016/j.jiph.2011.03.001

Anderson, J. B., Shuster, T. A., Hansen, K. E., Levy, A. S., & Volk, A. (2004). A Camera's view of consumer food-handling behaviors. *Journal of the American Dietetic Association, 104*(2), 186–191. doi: 10.1016/j.jada.2003.11.010

Aquilino, W. S. (1997). Privacy effects on self-reported drug use: Interactions with survey mode and respondent characteristics. In L. Harrison & A. Hughes (Eds.), *The validity of self-reported drug use: Improving the accuracy of survey estimates* (pp. 383–415). Rockeville, MD: U.S. Department of Health and Human Services.

Aquilino, W. S., Wright, D. L., & Supple, A. J. (2000). Response effects due to bystander presence in CASI and paper-and-pencil surveys of drug use and alcohol use. *Substance Use & Misuse, 35*(6-8), 845–867. doi: 10.3109/10826080009148424

Arnold, B., Arana, B., Mausezahl, D., Hubbard, A., & Colford, J. M., Jr. (2009). Evaluation of a pre-existing, 3-year household water treatment and handwashing intervention in rural Guatemala. *International Journal of Epidemiology, 38*(6), 1651–1661. doi: 10.1093/ije/dyp241

Aunger, R. V., & Curtis, V. (2014). The Evo-Eco approach to behaviour change. In D. W. Lawson & M. Gibson (Eds.), *Applied Evolutionary Anthropology. Darwinian Approaches to Contemporary World Issues* (Vol. Advances in the Evolutionary Analysis of Human Behaviour, pp. 271–295). New York, NY: Springer.

Aunger, R. V., Schmidt, W.-P., Ranpura, A., Coombes, Y., Mukiri Maina, P., Nkatha Matiko, C., & Curtis, V. (2010). Three kinds of psychological determinants for hand-washing behaviour in Kenya. *Social Science & Medicine, 70*(3), 383–391. doi: 10.1016/j.socscimed.2009.10.038

Bagozzi, R. P. (1992). The self-regulation of attitudes, intentions, and behavior. *Social Psychology Quarterly, 55*(2), 178–204. doi: 10.2307/2786945

Banatvala, N., & Zwi, A. B. (2000). Public health and humanitarian interventions: Developing the evidence base. *British Medical Journal, 321*(7253), 101–105. doi: 10.1136/bmj.321.7253.101

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. doi: 10.1037/0033-295x.84.2.191

Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology & Health, 13*(4), 623–649. doi: 10.1080/08870449808407422

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143–164. doi: 10.1177/1090198104263660

Bartholomew, L. K., Parcel, G. S., Kok, G., Gottlieb, N. H., & Fernandez, M. E. (2006). *Planning health promotion programs: An intervention mapping approach* (3rd ed.). San Francisco, CA: Jossey-Bass.

Bartram, J., & Cairncross, S. (2010). Hygiene, sanitation, and water: Forgotten foundations of health. *PLoS Medicine, 7*(11), e1000367. doi: 10.1371/journal.pmed.1000367

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*(3), 497–529. doi: 10.1037/0033-2909.117.3.497

Becker, M. H., Maiman, L. A., Kirscht, J. P., Don, P. H., & Drachman, R. H. (1977). The health belief model and prediction of dietary compliance: A field experiment. *Journal of Health and Social Behavior, 18*(4), 348–366. doi: 10.2307/2955344

Bender, R., & Lange, S. (2001). Adjusting for multiple testing—when and how? *Journal of Clinical Epidemiology, 54*(4), 343–349. doi: 10.1016/S0895-4356(00)00314-0

Biran, A. (2011). Enabling technologies for handwashing with soap: A case study on the tippy-tap in Uganda. In Water and Sanitation Program (Ed.), *Learning Note*. Washinton, D.C.: Water and Sanitation Program.

Biran, A., Curtis, V., Gautam, O. P., Greenland, K., Islam, M. S., Schmidt, W.-P., . . . Torondel, B. (2012). *Background paper on measuring WASH and food hygiene practices – definition of goals to be tackled post 2015 by the Joint Monitoring Programme*. London, United Kingdom: London School of Hygiene & Tropical Medicine.

Biran, A., Rabie, T., Schmidt, W., Juvekar, S., Hirve, S., & Curtis, V. (2008). Comparing the performance of indicators of hand-washing practices in rural Indian households. *Tropical Medicine & International Health, 13*(2), 278–285. doi: 10.1111/j.1365-3156.2007.02001.x

Biran, A., Schmidt, W.-P., Varadharajan, K. S., Rajaraman, D., Kumar, R., Greenland, K., . . . Curtis, V. (2014). Effect of a behaviour-change intervention on handwashing with soap in India (SuperAmma): A cluster-randomised trial. *The Lancet Global Health, 2*(3), e145–e154. doi: 10.1016/S2214-109X(13)70160-8

Biran, A., Schmidt, W.-P., Wright, R., Jones, T., Seshadri, M., Isaac, P., . . . Curtis, V. (2009). The effect of a soap promotion and hygiene education campaign on handwashing behaviour in rural India: A cluster randomised trial. *Tropical Medicine & International Health, 14*(10), 1303–1314. doi: 10.1111/j.1365-3156.2009.02373.x

Biran, A., Tabyshalieva, A., & Salmorbekova, Z. (2005). Formative research for hygiene promotion in Kyrgyzstan. *Health Policy and Planning, 20*(4), 213–221. doi: 10.1093/heapol/czi024

Bishara, A. J., & Hittner, J. B. (2012). Testing the significance of a correlation with nonnormal data: Comparison of Pearson, Spearman, transformation, and resampling approaches. *Psychological Methods, 17*(3), 399–417. doi: 10.1037/a0028087

Bittner, M. J., Rich, E. C., Turner, P. D., & Arnold Jr, W. H. (2002). Limited impact of sustained simple feedback based on soap and paper towel consumption on the frequency of hand washing in an adult intensive care unit. *Infection Control and Hospital Epidemiology, 23*(3), 120–126. doi: 10.1086/502020

Black, R. E., Cousens, S., Johnson, H. L., Lawn, J. E., Rudan, I., Bassani, D. G., . . . Mathers, C. (2010). Global, regional, and national causes of child mortality in 2008: A systematic analysis. *The Lancet, 375*, 1969–1987. doi: 10.1016/S0140-6736(10)60549-1

Botta, R. A., Dunker, K., Fenson-Hood, K., Maltarich, S., & McDonald, L. (2008). Using a relevant threat, EPPM and interpersonal communication to change hand-washing behaviours on campus. *Journal of Communication in Healthcare, 1*(4), 373–381. doi: 10.1179/175380608790912897

Bradburn, N. M. (2000). Temporal representation and event dating. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report. Implications for research and practice* (pp. 49–61). Mahwah, NJ: Lawrence Erlbaum Associates.

Breckler, S. J., & Wiggins, E. C. (1989). Affect versus evaluation in the structure of attitudes. *Journal of Experimental Social Psychology, 25*(3), 253–271. doi: 10.1016/0022-1031(89)90022-X

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: Evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436–457. doi: 10.1016/S1054-139X(03)00052-1

Brewer, N. T., Weinstein, N. D., Cuite, C. L., & Herrington Jr, J. E. (2004). Risk perceptions and their relation to risk behavior. *Annals of Behavioral Medicine, 27*(2), 125–130. doi: 10.1207/s15324796abm2702_7

Briere, E. C., Ryman, T. K., Cartwright, E., Russo, E. T., Wannemuehler, K. A., Nygren, B. L., . . . Quick, R. (2012). Impact of integration of hygiene kit distribution with routine immunizations on infant vaccine coverage and water treatment and handwashing practices of Kenyan mothers. *Journal of Infectious Diseases, 205*(suppl 1), S56–S64. doi: 10.1093/infdis/jir779

Briscoe, C., & Aboud, F. (2012). Behaviour change communication targeting four health behaviours in developing countries: A review of change techniques. *Social Science & Medicine, 75*(4), 612–621. doi: 10.1016/j.socscimed.2012.03.016

Brown, J., Cavill, S., Cumming, O., & Jeandron, A. (2012). Water, sanitation, and hygiene in emergencies: summary review and recommendations for further research. *Waterlines, 31*(1), 11–29. doi: 10.3362/1756-3488.2012.004

Brown, N. R. (2002). Encoding, representing, and estimating event frequencies: A multiple strategy perspective. In P. Sedlmeier & T. Betsch (Eds.), *Frequency processing and cognition* (pp. 37–53). New York, NY: Oxford University Press.

Bryan, A., Fisher, J. D., & Fisher, W. A. (2002). Tests of the mediational role of preparatory safer sexual behavior in the context of the theory of planned behavior. *Health Psychology, 21*(1), 71–80. doi: 10.1037/0278-6133.21.1.71

Bulmer, M., & Warwick, D. P. (1993). Chapter 11. Data collection. In M. Bulmer & D. P. Warwick (Eds.), *Social research in developing countries: Surveys and censuses in the Third World* (pp. 145–160). London, United Kingdom: UCL Press.

Burton, S., & Blair, E. (1991). Task conditions, response formulation processes, and response accuracy for behavioral frequency questions in surveys. *Public Opinion Quarterly, 55*(1), 50–79. doi: 10.1086/269241

Cairncross, S., Hunt, C., Boisson, S., Bostoen, K., Curtis, V., Fung, I. C. H., & Schmidt, W.-P. (2010a). Water, sanitation and hygiene for the prevention of diarrhoea. *International Journal of Epidemiology, 39*(suppl_1), 193–205. doi: 10.1093/ije/dyq035

Cairncross, S., Hunt, C., Boisson, S., Bostoen, K., Curtis, V., Fung, I. C. H., & Schmidt, W.-P. (2010b). Water, sanitation and hygiene for the prevention of diarrhoea. *International Journal of Epidemiology, 39*(suppl_1), 193-205. doi: 10.1093/ije/dyq035

Carels, R. A., Cacciapaglia, H. M., Rydin, S., Douglass, O. M., & Harper, J. (2006). Can social desirability interfere with success in a behavioral weight loss program? *Psychology & Health, 21*(1), 65–78. doi: 10.1080/14768320500102277

Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology, 39*(5), 752–766.

Cialdini, R. B., Demaine, L. J., Sagarin, B. J., Barrett, D. W., Rhoads, K., & Winter, P. L. (2006). Managing social norms for persuasive impact. *Social Influence, 1*(1), 3–15. doi: 10.1080/15534510500181459

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology, 24*, 201–234. doi: 10.1016/S0065-2601(08)60330-5

Clayton, D. A., & Griffith, C. J. (2008). Efficacy of an extended theory of planned behaviour model for predicting caterers' hand hygiene practices. *International Journal of Environmental Health Research, 18*(2), 83–98. doi: 10.1080/09603120701358424

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159. doi: 10.1037/0033-2909.112.1.155

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences*. Mahwah, NJ: Lawrence Erlbaum Associates.

Conner, M. (2010). Cognitive determinants of health behavior. In A. Steptoe (Ed.), *Handbook of behavioral medicine. Methods and applications* (pp. 19–30). New York, NY: Springer.

Conner, M., & Norman, P. (2009a). Predicting health behaviour: A social cognition approach. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 1–27). Maidenhead, United Kingdom: Open University Press.

Conner, M., & Norman, P. (Eds.). (2009b). *Predicting health behaviour: Research and practice with social cognition models* (2nd ed.). Maidenhead, United Kingdom: Open University Press.

Conner, M., & Sparks, P. (2009). Theory of planned behaviour and health behaviour. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 170–222). Maidenhead, United Kingdom: Open University Press.

Contzen, N., Meili, I., & Mosler, H.-J. (2015). Changing handwashing behavior in southern Ethiopia: A longitudinal study on infrastructural and commitment interventions. *Social Science & Medicine, 124*, 103–114. doi: 10.1016/j.socscimed.2014.11.006

Contzen, N., & Mosler, H.-J. (2013). Impact of different promotional channels on handwashing behaviour in an emergency context: Haiti post-earthquake public health promotions and cholera response. *Journal of Public Health, 21*(6), 559–573. doi: 10.1007/s10389-013-0577-4

Coombes, Y., & Devine, J. (2010). Introducing FOAM: A framework to analyze handwashing behaviors to design effective handwashing programs. *Water and Sanitation Program: Working Paper*. Washinton, D.C.: Water and Sanitation Program.

Cousens, S., Kanki, B., Toure, S., Diallo, I., & Curtis, V. (1996). Reactivity and repeatability of hygiene behaviour: Structured observations from Burkina Faso. *Social Science & Medicine, 43*(9), 1299–1308. doi: 10.1016/0277-9536(95)00380-0

Crisp, R. J., Walsh, J., & Hewstone, M. (2006). Crossed categorization in common ingroup contexts. *Personality and Social Psychology Bulletin, 32*(9), 1204–1218. doi: 10.1177/0146167206289409

Crowne, D. P., & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology, 24*(4), 349–354. doi: 10.1037/h0047358

Curtis, V. A., Cairncross, S., & Yonli, R. (2000). Review: Domestic hygiene and diarrhoea – pinpointing the problem. *Tropical Medicine & International Health, 5*(1), 22–32. doi: 10.1046/j.1365-3156.2000.00512.x

Curtis, V. A., Cousens, S., Mertens, T., Traore, E., Kanki, B., & Diallo, I. (1993). Structured observations of hygiene behaviours in Burkina Faso: Validity, variability, and utility. *Bulletin of the World Health Organization, 71*(1), 23–32.

Curtis, V. A., Danquah, L. O., & Aunger, R. V. (2009). Planned, motivated and habitual hygiene behaviour: An eleven country review. *Health Education Research, 24*(4), 655–673. doi: 10.1093/her/cyp002

Curtis, V. A., Kanki, B., Cousens, S., Diallo, I., Kpozehouen, A., Sangaré, M., & Nikiema, M. (2001). Evidence of behaviour change following a hygiene promotion programme in Burkina Faso. *Bulletin of the World Health Organization, 79*(6), 518–527. doi: 10.1590/S0042-96862001000600007

Curtis, V. A., Schmidt, W., Luby, S., Florez, R., Touré, O., & Biran, A. (2011). Hygiene: New hopes, new horizons. *The Lancet Infectious Diseases, 11*(4), 312–321. doi: 10.1016/s1473-3099(10)70224-3

Dangour, A. D., Watson, L., Cumming, O., Boisson, S., Che, Y., Velleman, Y., . . . Uauy, R. (2013). Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *Cochrane Database of Systematic Reviews*, (8). doi:10.1002/14651858.CD009382.pub2

David, N., Mumuni, O. K., & Awuku, N. N. (2009). *Participatory Hygiene and Sanitation Transformation (PHAST): A methodology for sustainable hygiene and sanitation behavior change with experience from the Bawku West District of Ghana*. Paper presented at the West Africa regional sanitation and hygiene symposium, Accra, Ghana.

Davidson, K. W., Goldstein, M., Kaplan, R., Kaufmann, P. G., Knatterud, G. L., Orleans, C. T., . . . Whitlock, E. P. (2003). Evidence-based behavioral medicine: What is it and how do we achieve it? *Annals of Behavioral Medicine, 26*(3), 161–171. doi: 10.1207/S15324796ABM2603_01

Debsu, D. N. (2013). Local institutions, external interventions, and adaptations to climate variability: The case of the Borana pastoralists in southern Ethiopia. In K. Pfeifer (Ed.), *Oxfam America Research Backgrounder series*. Boston, MA: Oxfam America.

DeMaio, T. J. (1984). Social desirability and survey measurement: A review. In C. F. Turner & E. Martin (Eds.), *Surveying subjective phenomena* (Vol. 2, pp. 257–282). New York, NY: Russel Sage Foundation.

Des Jarlais, D. C., Lyles, C., & Crepaz, N. (2004). Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: The TREND statement. *American Journal of Public Health, 94*(3), 361–366. doi: 10.2105/AJPH.94.3.361

Devine, J., Karver, J., Coombes, Y., Chase, C., & Hernandez, O. (2012). Behavioral determinants of handwashing with soap among mothers and caretakers: Emergent learning from Senegal and Peru. *Water and Sanitation Program: Learning note*. Washington, DC: Water and Sanitation Program.

Devine, J., & Koita, S. N. (2010). Senegal: A hand-washing behavior change journey. *Water and Sanitation Program: Learning Note*. Washington, DC: Water and Sanitation Program.

Devine, J., & Peschiera, R. F. (2010). Peru: A handwashing behavior change journey *Water and Sanitation Program: Learning note*. Washington, DC: Water and Sanitation Program.

Direction Nationale de l'Eau Potable et de l'Assainissement, & United Nations Children's Fund. (2011). *WASH Cluster Haiti*. Retrieved from http://www.dinepa.gouv.ht/wash_cluster/

Donaldson, S., & Grant-Vallone, E. (2002). Understanding self-report bias in organizational behavior research. *Journal of Business and Psychology, 17*(2), 245–260. doi: 10.1023/a:1019637632584

Drankiewicz, D., & Dundes, L. (2003). Handwashing among female college students *American Journal of Infection Control, 31*(2), 67–71. doi: 10.1067/mic.2003.6

Dreibelbis, R., Winch, P., Leontsini, E., Hulland, K., Ram, P., Unicomb, L., & Luby, S. (2013). The integrated behavioural model for water, sanitation, and hygiene: A systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings. *BMC Public Health, 13*(1), 1015. doi: 10.1186/1471-2458-13-1015

Eagly, A. H., Mladinic, A., & Otto, S. (1994). Cognitive and affective bases of attitudes toward social groups and social policies. *Journal of Experimental Social Psychology, 30*(2), 113–137. doi: 10.1006/jesp.1994.1006

Edwards, A. L. (1957). *The social desirability variable in personality assessment and research*. Ft Worth, TX: Dryden Press.

Ejemot, R. I., Ehiri, J. E., Meremikwu, M. M., & Critchley, J. A. (2008). Hand washing for preventing diarrhoea. *Cochrane Database of Systematic Reviews*, Issue 1. Art. No.: CD004265. doi: 10.1002/14651858.CD004265.pub2

Empelen, P., & Kok, G. (2008). Action-specific cognitions of planned and preparatory behaviors of condom use among Dutch adolescents. *Archives of Sexual Behavior, 37*(4), 626–640. doi: 10.1007/s10508-007-9286-9

Erasmus, V. (2012). *Compliance to hand hygiene guidelines in hospital care. A stepwise behavioural approach* (Doctoral dissertation). Retrieved from http://hdl.handle.net/1765/32161

Erasmus, V., Daha, T. J., Brug, H., Richardus, J. H., Behrendt, M. D., Vos, M. C., & van Beeck, E. F. (2010). Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infection Control and Hospital Epidemiology, 31*(3), 283–294. doi: 10.1086/650451

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009a). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149–1160. doi: 10.3758/BRM.41.4.1149

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009b). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149-1160. doi: 10.3758/BRM.41.4.1149

Federal Ministry of Health Ethiopia. (2011). Ethiopia national hand washing communication campaign strategy. Addis Ababa, Ethiopia: Federal Democratic Republic of Ethiopia.

Festinger, L. (1962). *A theory of cognitive dissonance*. Stanford, CA: Stanford university press.

Festinger, L. (1968). The relation between behavior and cognition. In J. S. Bruner (Ed.), *Contemporary approaches to cognition : A symposium held at the University of Colorado, 12-14 Mai 1955* (pp. 127–150). Cambridge, MA: Harvard University Press

Fewtrell, L., Kaufmann, R. B., Kay, D., Enanoria, W., Haller, L., & Colford, J. J. M. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: A systematic review and meta-analysis. *The Lancet Infectious Diseases, 5*(1), 42–52. doi: 10.1016/S1473-3099(04)01253-8

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. New York, NY: Wiley.

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. New York, NY: Psychology Press.

Flay, B. R., Snyder, F., & Petraitis, J. (2009). The theory of triadic influence. In R. J. DiClemente, R. A. Crosby & M. C. Kegler (Eds.), *Emerging theories in health promotion practice and research* (pp. 451–510). San Francisco, CA: John Wiley & Sons.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407–429. doi: 10.1111/j.1559-1816.2000.tb02323.x

Fotuhi, O., Fong, G. T., Zanna, M. P., Borland, R., Yong, H.-H., & Cummings, K. M. (2013). Patterns of cognitive dissonance-reducing beliefs among smokers: A longitudinal analysis from the International Tobacco Control (ITC) four country survey. *Tobacco Control, 22*(1), 52–58. doi: 10.1136/tobaccocontrol-2011-050139

Frick, J., Kaiser, F. G., & Wilson, M. (2004). Environmental knowledge and conservation behavior: Exploring prevalence and structure in a representative sample. *Personality and Individual Differences, 37*(8), 1597–1613. doi: 10.1016/j.paid.2004.02.015

Gittelsohn, J., Shankar, A. V., West, H. P. J., Ram, R. M., & Gnywali, T. (1997). Estimating reactivity in direct observation studies of health behaviors. *Human Organization, 56*(2), 182–189.

Glanz, K., & Bishop, D. B. (2010). The role of behavioral science theory in development and implementation of public health interventions. *Annual Review of Public Health, 31*(1), 399–418. doi: 10.1146/annurev.publhealth.012809.103604

Global Public-Private Partnership for Handwashing with Soap. (2013). *About the partnership.* Retrieved from http://www.globalhandwashing.org/about

Global WASH Cluster. (2009a). *Hygiene promotion in emergencies.* Retrieved from http://www.washcluster.info/?q=content/hygiene-promotion-emergencies

Global WASH Cluster. (2009b). Introduction to hygiene promotion: Tools and approaches. New York, NY: Global WASH Cluster.

Global WASH Cluster. (2011). *WASH visual aids library.* Retrieved from http://ceecis.org/washtraining/index.html

Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European Review of Social Psychology, 4*(1), 141–185. doi: 10.1080/14792779343000059

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist, 54*(7), 493–503. doi: 10.1037/0003-066X.54.7.493

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, Volume 38*, 69–119. doi: 10.1016/S0065-2601(06)38002-1

Greene, L. E., Freeman, M. C., Akoko, D., Saboori, S., Moe, C., & Rheingans, R. (2012). Impact of a school-based hygiene promotion and sanitation intervention on pupil hand contamination in Western Kenya: A cluster randomized trial. *The American Journal of Tropical Medicine and Hygiene, 87*(3), 385–393. doi: 10.4269/ajtmh.2012.11-0633

Guynn, M., McDaniel, M., & Einstein, G. (1998). Prospective memory: When reminders fail. *Memory & Cognition, 26*(2), 287–298. doi: 10.3758/BF03201140

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-Being, 6*(1), 1–47. doi: 10.1111/aphw.12017

Haggerty PA, Muladi K, Kirkwood BR, A, A., & Manunebo, M. (1994). Community-based hygiene education to reduce diarrhoeal disease in rural Zaire: Impact of the intervention on diarrhoeal morbidity. *International Journal of Epidemiology, 23*(5), 1050–1059. doi: 10.1093/ije/23.5.1050

Halder, A. K., Tronchet, C., Akhter, S., Bhuiya, A., Johnston, R. B., & Luby, S. P. (2010). Observed hand cleanliness and other measures of handwashing behavior in rural Bangladesh. *BMC Public Health, 10*(545). doi: 10.1186/1471-2458-10-545

Han, A. M., & Hlaing, T. (1989). Prevention of diarrhoea and dysentery by hand washing. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 83*(1), 128–131. doi: 10.1016/0035-9203(89)90737-2

Hanley, J. A., Negassa, A., Edwardes, M. D., & Forrester, J. E. (2003). Statistical analysis of correlated data using generalized estimating equations: An orientation. *American Journal of Epidemiology, 157*(4), 364–375. doi: 10.1093/aje/kwf215

Hawkins, D. M. (2003). The problem of overfitting. *Journal of Chemical Information and Computer Sciences, 44*(1), 1–12. doi: 10.1021/ci0342472

Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology, 67*(3), 451–470. doi: 10.1111/bmsp.12028

Heeb, J.-L., & Gmel, G. (2005). Measuring alcohol consumption: A comparison of graduated frequency, quantity frequency, and weekly recall diary methods in a general population survey. *Addictive Behaviors, 30*(3), 403–413. doi: 10.1016/j.addbeh.2004.04.022

Hershfield, A. F., Rohling, N. G., Kerr, G. B., & Hursh-César, G. (1993). Chapter 19. Fieldwork in rural areas. In M. Bulmer & D. P. Warwick (Eds.), *Social research in developing countries. Surveys and censuses in the Third World* (pp. 241–252). London, UK: UCL Press.

Hoffmeyer-Zlotnik, J. H. P. (2003). New sampling designs and the quality of data. In A. Ferligoj & A. Mrvar (Eds.), *Developments in applied statistics* (Vol. 19, pp. 205–217). Ljubljana, Slovenia: FDV.

Holbrook, A. L., & Krosnick, J. A. (2010). Social desirability bias in voter turnout reports. *Public Opinion Quarterly, 74*(1), 37–67. doi: 10.1093/poq/nfp065

Hoque, B. A., Juncker, T., Sack, R. B., Ali, M., & Aziz, K. M. (1996). Sustainability of a water, sanitation and hygiene education project in rural Bangladesh: A 5-year follow-up. *Bulletin of the World Health Organization, 74*(4), 431–437.

Huber, A. C., Bhend, S., & Mosler, H.-J. (2012). Determinants of exclusive consumption of fluoride-free water: A cross-sectional household study in rural Ethiopia. *Journal of Public Health, 20*(3), 269–278. doi: 10.1007/s10389-011-0445-z

Huber, A. C., & Mosler, H.-J. (2013). Determining behavioral factors for interventions to increase safe water consumption: A cross-sectional field study in rural Ethiopia. *International Journal of Environmental Health Research, 23*(2), 96–107. doi: 10.1080/09603123.2012.699032

Huber, A. C., Tobias, R., & Mosler, H.-J. (2014). Evidence-Based Tailoring of Behavior-Change Campaigns: Increasing Fluoride-Free Water Consumption in Rural Ethiopia with Persuasion. *Applied Psychology: Health and Well-Being, 6*(1), 96–118. doi: 10.1111/aphw.12018

Huda, T. M. N., Unicomb, L., Johnston, R. B., Halder, A. K., Yushuf Sharker, M. A., & Luby, S. P. (2012). Interim evaluation of a large scale sanitation, hygiene and water improvement programme on childhood diarrhea and respiratory disease in rural Bangladesh. *Social Science & Medicine, 75*(4), 604–611. doi: 10.1016/j.socscimed.2011.10.042

Humphrey, J. H. (2009). Child undernutrition, tropical enteropathy, toilets, and handwashing. *The Lancet, 374*(9694), 1032–1035. doi: 10.1016/S0140-6736(09)60950-8

Hussain, A., Kvåle, G., & Aarø, L. E. (1997). Impact of a Health Education Program to Promote Consumption of Vitamin A Rich Foods in Bangladesh. *Health Promotion International, 12*(2), 103–109. doi: 10.1093/heapro/12.2.103

Hutin, Y., Luby, S., & Paquet, C. (2003). A large cholera outbreak in Kano City, Nigeria: The importance of hand washing with soap and the danger of street-vended water. *Journal of Water and Health, 1*(1), 45–52.

Hygiene Promotion sub-cluster Haiti. (2010). Hygiene promotion strategy. Cholera response Haiti. In Direction Nationale de l'Eau Potable et de l'Assainissement & United Nations Children's Fund (Ed.). Port-au-Prince, Haiti.

Inauen, J., & Mosler, H.-J. (2013). Developing and testing theory-based and evidence-based interventions to promote switching to arsenic-safe wells in Bangladesh. *Journal of Health Psychology,* Advance online publication. doi: 10.1177/1359105313493811

Inauen, J., Tobias, R., & Mosler, H.-J. (2013). Predicting water consumption habits for seven arsenic-safe water options in Bangladesh. *BMC Public Health, 13*(1), 417. doi: 10.1186/1471-2458-13-417

Inauen, J., Tobias, R., & Mosler, H.-J. (2014). The role of commitment strength in enhancing safe water consumption: Mediation analysis of a cluster-randomized trial. *British Journal of Health Psychology, 19*(4), 701–719. doi: 10.1111/bjhp.12068

Iyer, P., Sara, J., Curtis, V., Scott, B., & Cardosi, J. (2005). *The handwashing handbook. A guide for developing a hygiene promotion program to increase handwashing with soap*. Washington, DC: Water and Sanitation Program.

Jagals, P., Nala, N., Tsubane, T., Moabi, M., & Motaung, K. (2004). Measuring changes in water-related health and hygiene practices by developing-community households. *Water Science & Technology*, *50*(1), 91–97.

Jenner, E. A., Fletcher, B., Watson, P., Jones, F. A., Miller, L., & Scott, G. M. (2006). Discrepancy between self-reported and observed hand hygiene behaviour in healthcare professionals. *Journal of Hospital Infection, 63*(4), 418–422. doi: 10.1016/j.jhin.2006.03.012

Jenner, E. A., Watson, P. W. B., Miller, L., Jones, F., & Scott, G. M. (2002). Explaining hand hygiene practice: An extended application of the theory of planned behaviour. *Psychology, Health & Medicine, 7*(3), 311–326. doi: 10.1080/13548500220139412

Judah, G., Aunger, R. V., Schmidt, W.-P., Michie, S., Granger, S., & Curtis, V. (2009). Experimental pretesting of hand-washing interventions in a natural setting. *American Journal of Public Health, 99*(S2), 405–411. doi: 10.2105/AJPH.2009.164160

Kantola, S. J., Syme, G. J., & Campbell, N. A. (1984). Cognitive dissonance and energy conservation. *Journal of Applied Psychology, 69*(3), 416–421. doi: 10.1037/0021-9010.69.3.416

Keutzer, C. S. (1968). A measure of cognitive dissonance as a predictor of smoking treatment outcome. *Psychological Reports, 22*(2), 655–658. doi: 10.2466/pr0.1968.22.2.655

Khan, M. U. (1982). Interruption of shigellosis by hand washing. *Transactions of The Royal Society of Tropical Medicine and Hygiene, 76*(2), 164–168. doi: 10.1016/0035-9203(82)90266-8

Kim, Y. M., Kols, A., Nyakauru, R., Marangwanda, C., & Chibatamoto, P. (2001). Promoting sexual responsibility among young people in Zimbabwe. *International Family Planning Perspectives, 27*(1), 11–19. doi: 10.2307/2673800

King, M. F., & Bruner, G. C. (2000). Social desirability bias: A neglected aspect of validity testing. *Psychology & Marketing, 17*(2), 79–103. doi: 10.1002/(SICI)1520-6793(200002)17:2<79::AID-MAR2>3.0.CO;2-0

Korhonen, T., Uutela, A., Korhonen, H. J., & Puska, P. (1998). Impact of mass media and interpersonal health communication on smoking cessation attempts: A study in North Karelia, 1989-1996. *Journal of Health Communication, 3*(2), 105–118. doi: 10.1080/108107398127409

Koring, M., Parschau, L., Lange, D., Fleig, L., Knoll, N., & Schwarzer, R. (2013). Preparing for physical activity: Pedometer acquisition as a self-regulatory strategy. *Applied Psychology: Health and Well-Being, 5*(1), 136–147. doi: 10.1111/aphw.12003

Kraemer, S. M., & Mosler, H.-J. (2012). Effectiveness and effects of promotion strategies for behaviour change: Solar water disinfection in Zimbabwe. *Applied Psychology, 61*(3), 392–414. doi: 10.1111/j.1464-0597.2011.00475.x

Kreuter, M. W., Lukwago, S. N., Bucholtz, D. C., Clark, E. M., & Sanders-Thompson, V. (2003). Achieving cultural appropriateness in health promotion programs: Targeted and tailored approaches. *Health Education & Behavior, 30*(2), 133–146. doi: 10.1177/1090198102251021

Kristiansen, C. M., & Harding, C. M. (1984). The social desirability of preventive health behavior. *Public Health Reports, 99*(4), 384–388. doi: 10.2307/4627663

Lally, P., & Gardner, B. (2011). Promoting habit formation. *Health Psychology Review, 7*(sup1), S137–S158. doi: 10.1080/17437199.2011.603640

Leventhal, H., Musumeci, T. J., & Contrada, R. J. (2007). Current issues and new directions in Psychology and Health: Theory, translation, and evidence-based practice. *Psychology & Health, 22*(4), 381–386. doi: 10.1080/03932720601160476

Linscott, A. J. (2007). Natural disasters — a microbe's paradise. *Clinical Microbiology Newsletter, 29*(8), 57–62. doi: 10.1016/j.clinmicnews.2007.04.001

Lippke, S., & Ziegelmann, J. P. (2008). Theory-based health behavior change: Developing, testing, and applying theories for evidence-based interventions. *Applied Psychology, 57*(4), 698–716. doi: 10.1111/j.1464-0597.2008.00339.x

Loftus, E. F., Levidow, B., & Duensing, S. (1992). Who remembers best? Individual differences in memory for events that occurred in a science museum. *Applied Cognitive Psychology, 6*(2), 93–107. doi: 10.1002/acp.2350060202

Lokhorst, A. M., Werner, C., Staats, H., van Dijk, E., & Gale, J. L. (2013). Commitment and behavior change: A meta-analysis and critical review of commitment-making strategies in environmental research. *Environment and Behavior, 45*(1), 3–34. doi: 10.1177/0013916511411477

Luby, S. P., Agboatwalla, M., Bowen, A., Kenah, E., Sharker, Y., & Hoekstra, R. M. (2009). Difficulties in maintaining improved handwashing behavior, Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene, 81*(1), 140–145.

Luby, S. P., Agboatwalla, M., Feikin, D. R., Painter, J., Billhimer, W., Altaf, A., & Hoekstra, R. M. (2005). Effect of handwashing on child health: A randomised controlled trial. *The Lancet, 366*(9481), 225–233. doi: 10.1016/S0140-6736(05)66912-7

Luby, S. P., Halder, A. K., Huda, T., & Johnston, R. B. (2011). The effect of handwashing at recommended times with water alone and with soap on child diarrhea in rural Bangladesh: An observational study. *PLoS Medicine, 8*(6), e1001052. doi: 10.1371/journal.pmed.1001052

Luby, S. P., Halder, A. K., Huda, T. M. N., Unicomb, L., & Johnston, R. B. (2011). Using child health outcomes to identify effective measures of handwashing. *American Journal of Tropical Medicine and Hygiene, 85*(5), 882–892. doi: 10.4269/ajtmh.2011.11-0142

Luby, S. P., Halder, A. K., Tronchet, C., Akhter, S., Bhuiya, A., & Johnston, R. B. (2009). Household characteristics associated with handwashing with soap in rural Bangladesh. *American Journal of Tropical Medicine and Hygiene, 81*(5), 882–887. doi: 10.4269/ajtmh.2009.09-0031

Luby, S. P., Kadir, M. A., Yushuf Sharker, M. A., Yeasmin, F., Unicomb, L., & Sirajul Islam, M. (2010). A community-randomised controlled trial promoting waterless hand sanitizer and handwashing with soap, Dhaka, Bangladesh. *Tropical Medicine and International Health, 15*(12), 1508–1516. doi: 10.1111/j.1365-3156.2010.02648.x

Luszczynska, A., & Schwarzer, R. (2003). Planning and self-efficacy in the adoption and maintenance of breast self-examination: A longitudinal study on self-regulatory cognitions. *Psychology & Health, 18*(1), 93–108. doi: 10.1080/0887044021000019358

Luszczynska, A., & Schwarzer, R. (2009). Social cognitive theory. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 127–169). Maidenhead, United Kingdom: Open University Press.

Maas, C. J. M., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology, 1*(3), 86–92. doi: 10.1027/1614-1881.1.3.86

Manun'Ebo, M., Cousens, S., Haggerty, P., Kalengaie, M., Ashworth, A., & Kirkwood, B. (1997). Measuring hygiene practices: A comparison of questionnaires with direct observations in rural Zaïre. *Tropical Medicine & International Health, 2*(11), 1015–1021. doi: 10.1046/j.1365-3156.1997.d01-180.x

Mathers, C., & Stevens, G. (2013). WHO methods and data sources for global burden of disease estimates 2000-2011. In Department of Health Statistics and Information Systems (Ed.), *Global Health Estimates Technical Paper WHO/HIS/HSI/GHE/2013.4*. Geneva, Switzerland: World Health Organization.

McDowell, I. (2006). *Measuring health: A guide to rating scales and questionnaires* (3rd ed.). New York, NY: Oxford University Press.

McLaws, M.-L., Maharlouei, N., Yousefi, F., & Askarian, M. (2012). Predicting hand hygiene among Iranian health care workers using the theory of planned behavior. *American Journal of Infection Control, 40*(4), 336–339. doi: 10.1016/j.ajic.2011.04.004

McMaster, C., & Lee, C. (1991). Cognitive dissonance in tobacco smokers. *Addictive Behaviors, 16*(5), 349–353. doi: 10.1016/0306-4603(91)90028-G

Menon, G. (1993). The effects of accessibility of information in memory on judgments of behavioral frequencies. *Journal of Consumer Research*, 431–440.

Menon, G., & Yorkston, E. A. (2000). The use of memory and contextual cues in the formation of behavioral frequency judgments. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report. Implications for research and practice* (pp. 63–79). Mahwah, NJ: Lawrence Erlbaum Associates.

Metwally, A. M., Saad, A., Ibrahim, N. A., Emam, H. M., & El-Etreby, L. A. (2007). Monitoring progress of the role of integration of environmental health education with water and sanitation services in changing community behaviours. *International Journal of Environmental Health Research, 17*(1), 61–74. doi: 10.1080/09603120600937856

Michie, S., & Abraham, C. (2004). Interventions to change health behaviours: Evidence-based or evidence-inspired? *Psychology & Health, 19*(1), 29–49. doi: 10.1080/0887044031000141199

Michie, S., & Johnston, M. (2012). Theories and techniques of behaviour change: Developing a cumulative science of behaviour change. *Health Psychology Review, 6*(1), 1–6. doi: 10.1080/17437199.2012.654964

Michie, S., Johnston, M., Francis, J., Hardeman, W., & Eccles, M. (2008). From theory to intervention: Mapping theoretically derived behavioural determinants to behaviour change techniques. *Applied Psychology, 57*(4), 660–680. doi: 10.1111/j.1464-0597.2008.00341.x

Michie, S., & Prestwich, A. (2010). Are interventions theory-based? Development of a theory coding scheme. *Health Psychology, 29*(1), 1–8. doi: 10.1037/a0016939

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., . . . Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine, 46*(1), 81–95. doi: 10.1007/s12160-013-9486-6

Michie, S., Rothman, A. J., & Sheeran, P. (2007). Current issues and new direction in Psychology and Health: Advancing the science of behavior change. *Psychology & Health, 22*(3), 249–253. doi: 10.1080/14768320701233582

Mikolajczak, J. (2008). *Promoting HIV-testing among MSM in The Netherlands* (Doctoral dissertation). Retrieved from http://arno.unimaas.nl/show.cgi?fid=12820

Mikolajczak, J., Kok, G., & Hospers, H. J. (2008). Queermasters: Developing a theory- and evidence-based internet HIV-prevention intervention to promote HIV-testing among men who have sex with men (MSM). *Applied Psychology: An International Review, 57*(4), 681–697. doi: 10.1111/j.1464-0597.2008.00342.x

Miller, S., Yardley, L., & Little, P. (2011). Development of an intervention to reduce transmission of respiratory infections and pandemic flu: Measuring and predicting hand-washing intentions. *Psychology, Health & Medicine, 17*(1), 59–81. doi: 10.1080/13548506.2011.564188

Ministère de la Santé Publique et de la Population. (2013). Rapport de cas. 14 avril 2013. Port-au-Prince, Haiti: Ministère de la Santé Publique et de la Population.

Mitchell, K. J., Nakamanya, S., Kamali, A., & Whitworth, J. A. G. (2001). Community-based HIV/AIDS education in rural Uganda: Which channel is most effective? *Health Education Research, 16*(4), 411–423. doi: 10.1093/her/16.4.411

Mitchell, R. E. (1965). Survey materials collected in the developing countries: Sampling, measurement, and interviewing obstacles to intra- and inter-national comparisons. *International Social Science Journal, 17*(4), 665–685.

Moshfegh, A. J., Rhodes, D. G., Baer, D. J., Murayi, T., Clemens, J. C., Rumpler, W. V., . . . Cleveland, L. E. (2008). The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *The American Journal of Clinical Nutrition, 88*(2), 324–332.

Mosler, H.-J. (2012). A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: A conceptual model, a review, and a guideline. *International Journal of Environmental Health Research, 22*(5), 431–449. doi: 10.1080/09603123.2011.650156

Mosler, H.-J., & Tobias, R. (2007). Umweltpsychologische Interventionsformen neu gedacht [Rethinking forms of interventions of environmental psychology]. *Umweltpsychologie [Environmental Psychology], 11*(1), 35–54.

Moss, W. J., Ramakrishnan, M., Storms, D., Henderson, S. A., Weiss, W. M., Lejnev, I., & Muhe, L. (2006). Child health in complex emergencies. *Bulletin of the World Health Organization, 84*(1), 58–64. doi: 10.1590/S0042-96862006000100015

Murray, C. J. L., Vos, T., Lozano, R., Naghavi, M., Flaxman, A. D., Michaud, C., . . . Lopez, A. D. (2012). Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *The Lancet, 380*(9859), 2197–2223. doi: 10.1016/S0140-6736(12)61689-4

Näher, A.-F., & Krumpal, I. (2012). Asking sensitive questions: The impact of forgiving wording and question context on social desirability bias. *Quality & Quantity, 46*(5), 1601–1616. doi: 10.1007/s11135-011-9469-2

Naikoba, S., & Hayward, A. (2001). The effectiveness of interventions aimed at increasing handwashing in healthcare workers - a systematic review. *Journal of Hospital Infection, 47*(3), 173–180. doi: 10.1053/jhin.2000.0882

Nicassio, P. M., Meyerowitz, B. E., & Kerns, R. D. (2004). The future of health psychology interventions. *Health Psychology, 23*(2), 132–137. doi: 10.1037/0278-6133.23.2.132

Norman, P., Boer, H., & Seydel, E. R. (2009). Protection motivation theory. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 81–126). Maidenhead, United Kingdom: Open University Press.

O'Boyle, C. A., Henly, S. J., & Larson, E. (2001). Understanding adherence to hand hygiene recommendations: The theory of planned behavior. *American Journal of Infection Control, 29*(6), 352–360. doi: 10.1067/mic.2001.18405

Ochsner, S., Scholz, U., & Hornung, R. (2013). Testing phase-specific self-efficacy beliefs in the context of dietary behaviour Change. *Applied Psychology: Health and Well-Being, 5*(1), 99–117. doi: 10.1111/j.1758-0854.2012.01079.x

Odhiambo, F., & Reed, B. (2013). Hygiene promotion in emergencies. In B. Reed (Ed.), *Technical notes on drinking-water, sanitation and hygiene in emergencies 10*. Geneva, CH: World Health Organization & Water Engineering and Development Centre.

Olshavsky, R. W., & Summers, J. O. (1974). A study of the role of beliefs and intentions in consistency restoration. *Journal of Consumer Research*, 63–70.

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: Habit as cue-contingent automaticity. *Health Psychology, 29*(4), 374–383. doi: 10.1037/a0019596

Painter, J. E., Borba, C. P. C., Hynes, M., Mays, D., & Glanz, K. (2008). The use of theory in health behavior research from 2000 to 2005: A systematic review. *Annals of Behavioral Medicine, 35*(3), 358–362. doi: 10.1007/s12160-008-9042-y

Pan American Health Organization, & World Health Organization. (2011). Earthquake in Haiti—one year later. *PAHO/WHO report on the health situation*. Washington, DC: Pan American Health Organization & World Health Organization.

Parker, D., Manstead, A. S. R., & Stradling, S. G. (1995). Extending the theory of planned behaviour: The role of personal norm. *British Journal of Social Psychology, 34*(2), 127–138. doi: 10.1111/j.2044-8309.1995.tb01053.x

Parkinson, J. (2009). *A review of the evidence base for WASH interventions in emergency responses. Discussion document*. OneResponse. Geneva, Switzerland.

Paulhus, D. L. (1984). Two-component models of socially desirable responding. *Journal of Personality and Social Psychology, 46*(3), 598–609. doi: 10.1037/0022-3514.46.3.598

Paulhus, D. L. (1991). Measurement and control of response bias. In J. P. Robinson, P. R. Shaver & L. S. Wrightsman (Eds.), *Measures of personality and social psychological attitudes* (Vol. 1, pp. 17–59). San Diego, CA: Academic Press.

Peal, A., Evans, B., & van der Voorden, C. (2010). Hygiene and sanitation software. An overview of approaches. Geneva, Switzerland: Water Supply & Sanitation Collaborative Council.

Perlini, A. H., & Ward, C. (2000). HIV prevention interventions: The effects of role-play and behavioural commitment on knowledge and attitudes. *Canadian Journal of Behavioural Science, 32*(3), 133–143. doi: 10.1037/h0087108

Pessoa-Silva, C. L., Hugonnet, S., Pfister, R., Touveneau, S., Dharan, S., Posfay-Barbe, K., & Pittet, D. (2007). Reduction of health care–associated infection risk in neonates by successful hand hygiene promotion. *Pediatrics, 120*(2), e382–e390. doi: 10.1542/peds.2006-3712

Pessoa-Silva, C. L., Posfay-Barbe, K., Pfister, R., Touveneau, S., Perneger, T. V., & Pittet, D. (2005). Attitudes and perceptions toward hand hygiene among healthcare workers caring for critically ill neonates. *Infection Control and Hospital Epidemiology, 26*(3), 305–311. doi: 10.1086/502544

Phillips, D. L., & Clancy, K. J. (1972). Some effects of "social desirability" in survey studies. *American Journal of Sociology, 77*(5), 921–940. doi: 10.2307/2776929

Pinfold, J. V. (1999). Analysis of different communication channels for promoting hygiene behaviour. *Health Education Research, 14*(5), 629–639. doi: 10.1093/her/14.5.629

Pinfold, J. V., & Horan, N. J. (1996). Measuring the effect of a hygiene behaviour intervention by indicators of behaviour and diarrhoeal disease. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 90*(4), 366–371. doi: 10.1016/s0035-9203(96)90507-6

Porzig-Drummond, R., Stevenson, R., Case, T., & Oaten, M. (2009). Can the emotion of disgust be harnessed to promote hand hygiene? Experimental and field-based tests. *Social Science & Medicine, 68*(6), 1006–1012. doi: 10.1016/j.socscimed.2009.01.013

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*(3), 879–891. doi: 10.3758/BRM.40.3.879

Prestwich, A., Sniehotta, F. F., Whittington, C., Dombrowski, S. U., Rogers, L., & Michie, S. (2014). Does theory influence the effectiveness of health behavior interventions? Meta-analysis. *Health Psychology, 33*(5), 465–474. doi: 10.1037/a0032853

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of consulting and clinical psychology, 51*(3), 390–395. doi: 10.1037/0022-006X.51.3.390

Prochaska, J. O., DiClemente, C. C., & Norcross, J. C. (1992). In search of how people change: Applications to addictive behaviors. *The American Psychologist, 47*(9), 1102–1114. doi: 10.1037/0003-066X.47.9.1102

Rabie, T., & Curtis, V. (2006). Handwashing and risk of respiratory infections: A quantitative systematic review. *Tropical Medicine & International Health, 11*(3), 258–267. doi: 10.1111/j.1365-3156.2006.01568.x

Ram, P. (2010). Practical guidance for measuring handwashing behavior. *Water and Sanitation Program: Working Paper*. Washington, DC: Water and Sanitation Program.

Ram, P. (2013). Practical guidance for measuring handwashing behavior: 2013 update. *Water and Sanitation Program: Working Paper*. Washington, DC: Water and Sanitation Program.

Randall, D. M., & Fernandes, M. F. (1991). The social desirability response bias in ethics research. *Journal of Business Ethics, 10*(11), 805–817. doi: 10.1007/BF00383696

Ravallion, M., Chen, S., & Sangraula, P. (2009). Dollar a day revisited. *The World Bank Economic Review, 23*(2), 163–184. doi: 10.1093/wber/lhp007

Reiser, B. J., Black, J. B., & Abelson, R. P. (1985). Knowledge structures in the organization and retrieval of autobiographical memories. *Cognitive Psychology, 17*(1), 89–137. doi: 10.1016/0010-0285(85)90005-2

Reynolds, W. M. (1982). Development of reliable and valid short forms of the Marlowe-Crowne Social Desirability Scale. *Journal of Clinical Psychology, 38*(1), 119–125. doi: 10.1002/1097-4679(198201)38:1<119::aid-jclp2270380118>3.0.co;2-i

Rhee, V., Mullany, L. C., Khatry, S. K., Katz, J., LeClerq, S. C., Darmstadt, G. L., & Tielsch, J. M. (2008). Maternal and birth attendant hand washing and neonatal mortality in southern Nepal. *Archives of Pediatrics & Adolescent Medicine, 162*(7), 603–608. doi: 10.1001/archpedi.162.7.603

Rippetoe, P. A., & Rogers, R. W. (1987). Effects of components of protection-motivation theory on adaptive and maladaptive coping with a health threat. *Journal of Personality and Social Psychology, 52*(3), 596–604. doi: 10.1037/0022-3514.52.3.596

Rivis, A., & Sheeran, P. (2003). Descriptive norms as an additional predictor in the theory of planned behaviour: A meta-analysis. *Current Psychology, 22*(3), 218–233. doi: 10.1007/s12144-003-1018-2

Roese, N. J., & Jamieson, D. W. (1993). Twenty years of bogus pipeline research: A critical review and meta-analysis. *Psychological Bulletin, 114*(2), 363–375. doi: 10.1037/0033-2909.114.2.363

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *The Journal of Psychology, 91*(1), 93–114. doi: 10.1080/00223980.1975.9915803

Rosenstock, I. M. (1966). Why people use health services. *The Milbank Memorial Fund Quarterly, 44*(3), 94–127.

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs, 15*, 175–183. doi: 10.1177/109019817400200403

Rossiter, J. R. (2011). Marketing measurement revolution: The C-OAR-SE method and why it must replace psychometrics. *European Journal of Marketing, 45*(11/12), 1561–1588. doi: 10.1108/03090561111167298

Rothman, A. (2004). "Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory. *International Journal of Behavioral Nutrition and Physical Activity, 1*(1), 11. doi: 10.1186/1479-5868-1-11

Sallis, J. F., Neville, O., & Fisher, E. B. (2008). Ecological models of health behavior. In K. Glanz, B. K. Rimer & K. Vismanath (Eds.), *Health behavior and health education: Theory, research, and practice* (pp. 565–485). San Francisco, CA: Jossey-Bass.

Sax, H., Uçkay, I., Richet, H., Allegranzi, B., & Pittet, D. (2007). Determinants of good adherence to hand hygiene among healthcare workers who have extensive exposure to hand hygiene campaigns. *Infection Control and Hospital Epidemiology, 28*(11), 1267–1274. doi: 10.1086/521663

Schwartz, S. H. (1973). Normative explanations of helping behavior: A critique, proposal, and empirical test. *Journal of Experimental Social Psychology, 9*(4), 349–364. doi: 10.1016/0022-1031(73)90071-1

Schwarz, N. (1990). Assessing frequency reports of mundane behaviors. Contribution of cognitive psychology to questionnaire construction. In C. Hendrick & M. S. Clark (Eds.), *Research methods in personality and social psychology* (pp. 98–119). Newpury Park, CA: Sage Publications.

Schwarz, N., & Hippler, H.-J. (1991). Response alternatives: The impact of their choice and presentation order. In P. P. Biemer, R. M. Grove, L. E. Lyberg, N. A. Mathiowetz & S. Sudman (Eds.), *Measurement errors in surveys* (pp. 41–56). Hoboken, NJ: John Wiley & Sons.

Schwarz, N., & Oyserman, D. (2001). Asking questions about behavior: Cognition, communication, and questionnaire construction. *American Journal of Evaluation, 22*(2), 127–160. doi: 10.1177/109821400102200202

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: Theoretical approaches and a new model. In R. Schwarzer (Ed.), *Self-efficacy: Thought control of action* (pp. 217–243). Washington, DC: Hemisphere Publishing Corporation.

Schwarzer, R. (2008). Modeling health behavior change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology, 57*(1), 1–29. doi: 10.1111/j.1464-0597.2007.00325.x

Schwarzer, R. (2013). Life and death of health behaviour theories. *Health Psychology Review, 8*(1), 53–56. doi: 10.1080/17437199.2013.810959

Schwarzer, R., Lippke, S., & Ziegelmann, J. P. (2008). Health action process approach. *Zeitschrift fur Gesundheitspsychologie [Journal of Health Psychology], 16*(3), 157–160. doi: 10.1026/0943-8149.16.3.157

Scott, B. E., Curtis, V., Rabie, T., & Garbrah-Aidoo, N. (2007). Health in our hands, but not in our heads: Understanding hygiene motivation in Ghana. *Health Policy and Planning, 22*(4), 225–233. doi: 10.1093/heapol/czm016

Scott, B. E., Schmidt, W.-P., Aunger, R., Garbrah-Aidoo, N., & Animashaun, R. (2008). Marketing hygiene behaviours: The impact of different communication channels on reported handwashing behaviour of women in Ghana. *Health Education Research, 23*(3), 392–401. doi: 10.1093/her/cym056

Shahid, N. S., Greenough III, W. B., Samadi, A. R., Huq, M. I., & Rahman, N. (1996). Hand washing with soap reduces diarrhoea and spread of bacterial pathogens in a Bangladesh village. *Journal of Diarrhoeal Diseases Research, 14*(2), 85–89.

Sheeran, P., Abraham, C., & Orbell, S. (1999). Psychosocial correlates of heterosexual condom use: A meta-analysis. *Psychological Bulletin, 125*(1), 90–132. doi: 10.1037/0033-2909.125.1.90

Sheeran, P., Milne, S., Webb, T. L., & Gollwitzer, P. M. (2009). Implementation intentions and health behaviour. In M. Conner & P. Norman (Eds.), *Predicting health behaviour: Research and practice with social cognition models* (2nd ed., pp. 276–323). Maidenhead, United Kingdom: Open University Press.

Silk, B. J., Doshi, S., Dutt, D., Hall, P., Salahuddin, G., Begum, M., . . . Ram, P. K. (2010). *Hand hygiene and radiographically-confirmed pneumonia among young children living in urban Dhaka, Bangladesh: Preliminary results from a case-control study* Paper presented at the American Society of Tropical Medicine and Hygiene 59th annual meeting, Atlanta, GA.

Silver, B. D., Abramson, P. R., & Anderson, B. A. (1986). The presence of others and overreporting of voting in American national elections. *Public Opinion Quarterly, 50*(2), 228–239. doi: 10.1086/268977

Simpson-Hebert, M., Sawyer, R., & Clarke, L. (1997). *The PHAST Initiative: Participatory Hygiene and Sanitation Transformation. A new approach to working with communities*. Geneva, Switzerland: World Health Organization & United Nations Development Program.

Sircar, B., Sengupta, P., Mondal, S., Gupta, D., Saha, N., Ghosh, S., . . . Pal, S. (1987). Effect of handwashing on the incidence of diarrhoea in a Calcutta slum. *Journal of Diarrhoeal Diseases Research*, 112–114.

Sniehotta, F. F., Nagy, G., Scholz, U., & Schwarzer, R. (2006). The role of action control in implementing intentions during the first weeks of behaviour change. *British Journal of Social Psychology, 45*(1), 87–106. doi: 10.1348/014466605X62460

Sniehotta, F. F., Scholz, U., & Schwarzer, R. (2005). Bridging the intention–behaviour gap: Planning, self-efficacy, and action control in the adoption and maintenance of physical exercise. *Psychology & Health, 20*(2), 143–160. doi: 10.1080/08870440512331317670

Sniehotta, F. F., Schwarzer, R., Scholz, U., & Schüz, B. (2005). Action planning and coping planning for long-term lifestyle change: Theory and assessment. *European Journal of Social Psychology, 35*(4), 565–576. doi: 10.1002/ejsp.258

Stanke, C., Kerac, M., Prudhomme, C., Medlock, J., & Murray, V. (2013). Health effects of drought: A systematic review of the evidence. *PLOS Currents Disasters, 5*. doi: 10.1371/currents.dis.7a2cee9e980f91ad7697b570bcc4b004

Stanton, B. F., Clemens, J. D., Aziz, K. M. A., & Rahman, M. (1987). Twenty-four-hour recall, knowledge-attitude-practice questionnaires, and direct observations of sanitary practices: A comparative study. *Bulletin of the World Health Organization, 65*(2), 217–222.

Stanton, B. F., Clemens, J. D., Khair, T., Khaiijx, K., & Jahan, D. A. (1987). An educational intervention for altering water-sanitation behaviours to reduce childhood diarrhoea in urban Bangladesh: Formulation, perparation and delivery of educational intervention. *Social Science & Medicine, 24*(3), 275–283.

Steadman Group. (2007). *Formative and baseline survey on handwashing with soap*. Kampala, Uganda: Water and Sanitation Program.

Stevenson, R. J., Case, T. I., Hodgson, D., Porzig-Drummond, R., Barouei, J., & Oaten, M. (2009). A scale for measuring hygiene behavior: Development, reliability and validity. *American Journal of Infection Control, 37*(7), 557–564. doi: 10.1016/j.ajic.2009.01.003

Sutton, S. (2008). How does the health action process approach (HAPA) bridge the intention–behavior gap? An examination of the model's causal structure. *Applied Psychology: An International Review, 57*(1), 66–74. doi: 10.1111/j.1464-0597.2007.00326.x

Sutton, S. (2009). Stage theories of health behaviour. In M. Conner & P. Norman (Eds.), *Predicting health behaviour* (pp. 223–275). Maidenhead, United Kingdom: Open University Press.

Tagliacozzo, R. (1979). Smokers' self-categorization and the reduction of cognitive dissonance. *Addictive Behaviors, 4*(4), 393–399. doi: 10.1016/0306-4603(79)90010-8

Tamas, A., Tobias, R., & Mosler, H.-J. (2009). Promotion of solar water disinfection: Comparing the effectiveness of different strategies in a longitudinal field study in Bolivia. *Health Communication, 24*(8), 711–722. doi: 10.1080/10410230903264022

Taylor, N., Conner, M., & Lawton, R. (2011). The impact of theory on the effectiveness of worksite physical activity interventions: A meta-analysis and meta-regression. *Health Psychology Review, 6*(1), 33–73. doi: 10.1080/17437199.2010.533441

Tedesco, L. A., Keffer, M. A., & Fleck-Kandath, C. (1991). Self-efficacy, reasoned action, and oral health behavior reports: A social cognitive approach to compliance. *Journal of Behavioral Medicine, 14*(4), 341–355. doi: 10.1007/BF00845111

The Sphere Project. (2011). The Sphere Project: Humanitarian charter and minimum standards in humanitarian response. Northampton, United Kingdom: The Sphere Project.

The World Bank. (n.d.). *The Participatory Hygiene and Sanitation Transformation (PHAST).* Retrieved from http://water.worldbank.org/shw-resource-guide/promotion/hygiene-promotion-approaches/phast#Analysis_PHAST

tippytap.org. (n.d.). *The tippy tap.* Retrieved from http://www.tippytap.org/the-tippy-tap

Tobias, R. (2009). Changing behavior by memory aids: A social psychological model of prospective memory and habit development tested with dynamic field data. *Psychological Review, 116*(2), 408–438. doi: 10.1037/a0015512

Tobias, R., Brügger, A., & Mosler, H.-J. (2009). Developing strategies for waste reduction by means of tailored interventions in Santiago de Cuba. *Environment and Behavior, 41*(6), 836-865. doi: 10.1177/0013916509338004

Tourangeau, R. (2000). Remembering what happened: Memory errors and survey reports. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report. Implications for research and practice* (pp. 29–47). Mahwah, NJ: Lawrence Erlbaum Associates.

Tourangeau, R., & Smith, T. W. (1996). Asking sensitive questions: The impact of data collection mode, question format, and question context. *Public Opinion Quarterly, 60*(2), 275–304. doi: 10.1086/297751

Tourangeau, R., & Yan, T. (2007). Sensitive questions in surveys. *Psychological Bulletin, 133*(5), 859–883. doi: 10.1037/0033-2909.133.5.859

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). *Rediscovering the social group: A self-categorization theory*. Cambridge, MA: Basil Blackwell.

U.S. Department of Health Education and Welfare. (1977). *Advances in health survey research methods*. Washington, DC: Government Printing Office.

United Nations Children's Fund. (2008). *Water, sanitation and hygiene: Hygiene promotion.* Retrieved from http://www.unicef.org/wash/index_43107.html

Unsworth, N., & Engle, R. W. (2007). The nature of individual differences in working memory capacity: Active maintenance in primary memory and controlled search from secondary memory. *Psychological Review, 114*(1), 104–132. doi: 10.1037/0033-295X.114.1.104

Updegraff, J. A., Emanuel, A. S., Gallagher, K. M., & Steinman, C. T. (2011). Framing flu prevention—An experimental field test of signs promoting hand hygiene during the 2009–2010 H1N1 pandemic. *Health Psychology, 30*(3), 295–299. doi: 10.1037/a0023125

Valente, T. W., & Saba, W. P. (1998). Mass media and interpersonal influence in a reproductive health communication campaign in Bolivia. *Communication Research, 25*(1), 96–124. doi: 10.1177/009365098025001004

van der Velde, F. W., Hooykaas, C., & van der Pligt, J. (1996). Conditional versus unconditional risk estimates in models of aids-related risk behaviour. *Psychology & Health, 12*(1), 87–100. doi: 10.1080/08870449608406924

Verardi, S., Dahourou, D., Ah-Kion, J., Bhowon, U., Tseung, C. N., Amoussou-Yeye, D., . . . Rossier, J. (2010). Psychometric properties of the Marlowe-Crowne Social Desirability Scale in eight African countries and Switzerland. *Journal of Cross-Cultural Psychology, 41*(1), 19–34. doi: 10.1177/0022022109348918

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology, 45*(3), 639–656. doi: 10.1348/014466605x49122

Vindigni, S. M., Riley, P. L., & Jhung, M. (2011). Systematic review: Handwashing behaviour in low- to middle-income countries: outcome measures and behaviour maintenance. *Tropical Medicine & International Health, 16*(4), 466–477. doi: 10.1111/j.1365-3156.2010.02720.x

Vivas, A. P., Gelaye, B., Aboset, N., Kumie, A., Berhane, Y., & Williams, M. A. (2010). Knowledge, attitudes and practices (KAP) of hygiene among school children in Angolela, Ethiopia. *Journal of Preventive Medicine and Hygiene, 51*(2), 73–79.

Vu, A., Tran, N., Pham, K., & Ahmed, S. (2011). Reliability of the Marlowe-Crowne social desirability scale in Ethiopia, Kenya, Mozambique, and Uganda. *BMC Medical Research Methodology, 11*(1), 162. doi: 10.1186/1471-2288-11-162

Vujcic, J., Blum, L., & Ram, P. (2014). *Strategies & challenges to handwashing promotion in humanitarian emergencies. Key informant interviews with agency experts*. Atlanta, GA: University at Buffalo.

Waddington, H., Snilstveit, B., White, H., & Fewtrell, L. (2009). Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries. Aberystwyth, United Kingdom: International Initiative for Impact Evaluation.

Walker, C. L. F., Rudan, I., Liu, L., Nair, H., Theodoratou, E., Bhutta, Z. A., . . . Black, R. E. (2013). Global burden of childhood pneumonia and diarrhoea. *The Lancet, 381*(9875), 1405–1416. doi: 10.1016/S0140-6736(13)60222-6

Waring, S. C., & Brown, B. J. (2005). The threat of communicable diseases following natural disasters: A public health response. *Disaster Management & Response, 3*(2), 41–47. doi: 10.1016/j.dmr.2005.02.003

Water Sanitation and Hygiene Research Group. (2012). Association of water storage and handwashing with death due to diarrhoea among children <5 years in Bangladesh. *Health and Science Bulletin, 10*(2), 7–16.

WaterAid. (2013). *Hygiene framework*. London, United Kingdom: WaterAid.

Waterkeyn, J., & Cairncross, S. (2005). Creating demand for sanitation and hygiene through community health clubs: A cost-effective intervention in two districts in Zimbabwe. *Social Science & Medicine, 61*(9), 1958–1970. doi: 10.1016/j.socscimed.2005.04.012

Watson, J. T., Gayer, M., & Connolly, M. A. (2007). Epidemics after natural disasters. *Emerging Infectious Diseases, 13*(1), 1–5. doi: 10.3201/eid1301.060779

Webb, T. L., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research, 12*(1), e4. doi: 10.2196/jmir.1376

Weinstein, N. D., Rothman, A. J., & Sutton, S. R. (1998). Stage theories of health behavior: Conceptual and methodological issues. *Health Psychology, 17*(3), 290–299. doi: 10.1037/0278-6133.17.3.290

Weisberg, H. F. (2005). *The total survey erroer approach: A guide to the new science of survey research*. Chigaco, IL: The University of Chicago Press.

Whitby, M., McLaws, M.-L., & Ross, M. W. (2006). Why healthcare workers don’t wash their hands: A behavioral explanation. *Infection Control and Hospital Epidemiology, 27*(5), 484–492. doi: 10.1086/503335

Williams, D. M. (2010). Importance of the nature of comparison conditions for testing theory-based interventions: Comment on Michie and Prestwich (2010). *Health Psychology, 29*(5), 467–467. doi: 10.1037/a0019597

Wilson, J. M., & Chandler, G. N. (1993). Sustained improvements in hygiene behaviour amongst village women in Lombok, Indonesia. *Transaction of the Royal Society of Tropical Medicine and Hygiene, 87*(6), 615–616. doi: 10.1016/0035-9203(93)90260-W

Wilson, J. M., Chandler, G. N., Muslihatun, & Jamiluddin. (1991). Hand-washing reduces diarrhoea episodes: A study in Lombok, Indonesia. *Transactions of The Royal Society of Tropical Medicine and Hygiene, 85*(6), 819–821. doi: 10.1016/0035-9203(91)90468-e

Wilson, S., Jacob, C. J., & Powell, D. (2011). Behavior-change interventions to improve hand-hygiene practice: A review of alternatives to education. *Critical Public Health, 21*(1), 119–127. doi: 10.1080/09581591003786122

Wisner, B., & Adams, J. (Eds.). (2002). *Environmental health in emergencies and disasters: A practical guide*. Geneva, Switzerland: World Health Organization.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2003). *At risk: Natural hazards, people's vulnerability and disasters* (2nd Ed.). Oxon, OX: Routledge.

World Health Organization. (2009). *WHO guidelines on hand hygiene in health care*. Geneva, Switzerland: World Health Organization.

World Health Organization. (2013). Diarrhoeal disease. *Fact sheet* (Vol. 330). Geneva, Switzerland: World Health Organization.

World Health Organization Regional Office for Africa. (2010). *Ethiopia: Health statistics profile 2010.* Retrieved from http://www.afro.who.int/en/ethiopia/country-health-profile.html

Wright, J., Gundry, S., & Conroy, R. (2004). Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use. *Tropical Medicine & International Health, 9*(1), 106–117. doi: 10.1046/j.1365-3156.2003.01160.x

Yardley, L., Miller, S., Teasdale, E., & Little, P. (2011). Using mixed methods to design a web-based behavioural intervention to reduce transmission of colds and flu. *Journal of Health Psychology, 16*(2), 353–364. doi: 10.1177/1359105310377538

You, D., Bastian, P., Wu, J., & Wardlaw, T. (2013). Levels and trends in child mortality. In UN Inter-agency Group for Child Mortality Estimation (Ed.). New York, NY: United Nations Children's Fund, World Health Organization, The World Bank, United Nations, Department of Economic and Social Affairs, United Nations Economic Commission for Latin America and the Caribbean Population Division.

Zhang, C., Mosa, A. J., Hayward, A. S., & Matthews, S. A. (2013). Promoting clean hands among children in Uganda: A school-based intervention using 'tippy-taps'. *Public Health, 127*(6), 586–589. doi: 10.1016/j.puhe.2012.10.020

Appendix

Appendix I: Additional information Part Two

Appendix II: Additional information Part Three

Appendix III: Additional information Part Four

Appendix I: Additional information for Part Two

Item wording of the social-cognitive factors and Cronbach's alphas

Table A-1. Item wording of the social-cognitive factors and Cronbach's alphas, Haiti

Factor groups	Construct	Items	α
Risk perception factors	Vulnerability	How high or low do you feel are the chances that you or someone in your family gets cholera? (-4 = *very low* to 4 = *very high*)	–
	Severity	Imagine that you contracted cholera, how severe would be the impact on…	.85
		… your life in general? (0 = *not severe* to 4 = *very severe*)	
		… your social life? (0 = *not severe* to 4 = *very severe*)	
		… your economic situation? (0 = *not severe* to 4 = *very severe*)	
	Health knowledge	Can you tell me what causes cholera?	.70
		What are the effects of cholera on your body?	
		Can you tell me how you can protect yourself and your family from getting cholera or diarrhea?	
		Can you tell me what you have to do if someone gets cholera?	
		(Open question format. Answers were scored according to correctness. 0 = *no knowledge* to 4 = *maximal knowledge score*)	
Attitude factors – instrumental	Instrumental beliefs	How certain are you that washing your hands with soap after defecation and before handling food prevents you and your family from getting diarrhea or cholera? (0 = *not certain* to 4 = *very certain*)	n/a
		I feel more attractive when I wash my hands with soap that smells good. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
		Do you think that washing hands with soap is something that demands effort? (0 = *not at all* to 4 = *very much*)	
		Do you think that washing hands with soap is something that takes time? (0 = *not at all* to 4 = *very much*)	
		Do you think that soap is too expensive for everyday handwashing? (0 = *not at all* to 4 = *very much*)	
		The device I use to wash my hands, for example handwashing station, sink, bucket, etc. is too far away to go there every time I should wash my hands. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
	Nurture[a]	I wash my hands with soap because I would risk the health of my children if I did not wash my hands with soap. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	.46
		I wash my hands because I want to set a good example for the children. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
Attitude factors – affective	Affective beliefs	Do you like or dislike washing hands with soap? (−4 = *I dislike it very much* to 4 = *I like it very much*)	.55
		Do you like or dislike the smell of the soap? (−4 = *I dislike it very much* to 4 = *I like it very much*)	
	Disgust, stool-related[b]	I feel dirty and smelly if I don't wash my hands with soap after visiting the toilet. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	–

(continued)

Table A-1 (continued). Item wording of the social-cognitive factors and Cronbach's alphas, Haiti

Factor groups	Construct	Items	α
	Disgust, food-related[b]	I wash my hands with soap before handling food because it would be disgusting to get dirt into the food and then eat it. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	−
Norm factors	Norms, stool-related	How many people of your relatives wash hands with soap after contact with stool? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	.69
		How many people of your community wash hands with soap after contact with stool? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	
		Most of the people who are important to me support me in washing hands with soap after contact with stool. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
		Most of the people who are important to me think I should wash my hands with soap after contact with stool. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
	Norms, food-related	How many people of your relatives wash hands with soap before handling food? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	.72
		How many people of your community wash hands with soap before handling food? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	
		Most of the people who are important to me support me in washing hands with soap before handling food. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
		Most of the people who are important to me think I should wash my hands with soap before handling food. (−4 = *I strongly disagree* to 4 = *I strongly agree*)	
Ability factors	Motivational self-efficacy, stool-related	Do you think you are able to always wash hands with soap after contact with stool? (0 = *not able* to 4 = *very able*)	−
	Motivational self-efficacy, food-related	Do you think you are able to always wash hands with soap before handling food? (0 = *not able* to 4 = *very able*)	−
	Volitional self-efficacy	Imagine you have stopped washing hands with soap for several days e.g. because the device you use to wash your hands was out of order. How confident are you to start washing hands with soap again? (0 = *not confident* to 4 = *very confident*)	−

(continued)

Table A-1 (continued). Item wording of the social-cognitive factors and Cronbach's alphas, Haiti

Factor groups	Construct	Items	α
	Impediments	How often does it happen that you want to wash hands with soap but there is something that hinders you in doing so? (0 = *(almost)* never to 4 = *(almost) always*)	.74
		How often does it happen that the device you use to wash your hands, for example handwashing station, sink, bucket etc. is damaged? (0 = *(almost)* never to 4 = *(almost) always*)	
		How often does it happen that the device you use to wash your hands, for example handwashing station, sink, bucket etc. is stolen? (0 = *(almost)* never to 4 = *(almost) always*)	
		How often does it happen that there is no water in the device you use to wash your hands, for example handwashing station, sink, bucket, etc.? (0 = *(almost)* never to 4 = *(almost) always*)	
		How often does it happen that there is no soap at the device you use to wash your hands, for example handwashing station, sink, bucket, etc.? (0 = *(almost)* never to 4 = *(almost) always*)	
Self-regulation factors	Coping planning, stool-related	Do you have a detailed plan of what you are doing when the device you use to wash your hands, for example handwashing station, sink, bucket etc. is out of order (e.g. damaged, no water or no soap)? (0 = *no detailed plan* to 4 = *very detailed plan*)	.80
		Do you have a detailed plan that helps you to not forget to wash your hands with soap after contact with stool? (0 = *no detailed plan* to 4 = *very detailed plan*)	
	Coping planning, food-related	Do you have a detailed plan of what you are doing when the device you use to wash your hands, for example handwashing station, sink, bucket, etc. is out of order (e.g. damaged, no water or no soap)? (0 = *no detailed plan* to 4 = *very detailed plan*)	.78
		Do you have a detailed plan that helps you to not forget to wash hands with soap before handling food? (0 = *no detailed plan* to 4 = *very detailed plan*)	
	Forgetting, stool-related	How often does it happen that you forget to wash hands with soap after contact with stool? (0 = *(almost)* never to 4 = *(almost) always*)	−
	Forgetting. food-related	How often does it happen that you forget to wash hands with soap before handling food? (0 = *(almost)* never to 4 = *(almost) always*)	−
	Commitment, stool-related	Do you feel committed to washing hands with soap after contact with stool? (0 = *not committed* to 4 = *very committed*)	−
	Commitment, food-related	Do you feel committed to washing hands with soap before handling food? (0 = *not committed* to 4 = *very committed*)	−

Note. n/a = not applicable: items are that diverse in content that a common variance is not expected and thus Cronbach's alphas are not applicable. Still, the items were combined to scales due to theoretical reasons. [a & b] Nurture and disgust were not combined into larger scales, to allow for examining their unique explanatory power.

Table A-2. Item wording of the social-cognitive factors and Cronbach's alphas, Ethiopia

Factor groups	Construct	Items	α
Risk perception factors	Vulnerability	How high do you feel is the risk that you'll get diarrhea? (0 = *no risk* to 4 = *high risk*)	.89
		How high do you feel is the risk that the child under the age of 5 in your household will get diarrhea? (0 = *no risk* to 4 = *high risk*)	
	Severity	Imagine that you contracted diarrhea. How severe would the impact be on…	.76
		… your life in general? (0 = *not severe* to 4 = *very severe*)	
		… your social life? (0 = *not severe* to 4 = *very severe*)	
		… your economic situation? (0 = *not severe* to 4 = *very severe*)	
		Imagine that the child under the age of 5 contracted diarrhea how severe would that be? (0 = *not severe* to 4 = *very severe*)	
	Health knowledge	Can you tell me what causes diarrhea?	.68
		What are the effects of diarrhea on your body?	
		Can you tell me how you can prevent getting diarrhea?	
		(Open question format. Answers were scored according to correctness. 0 = *no knowledge* to 4 = *maximal knowledge score*).	
Attitude factors	Instrumental beliefs	How certain are you that washing hands with soap and water after contact with stool and before handling food prevents you and your family from getting diarrhea? (0 = *not certain* to 4 = *very certain*)	n/a
		Do you feel more attractive when you wash your hands with soap and water? (0 = *not at all more attractive* to 4 = *much more attractive*)	
		(Do you think that washing hands with soap and water is expensive? (0 = *not at all* to 4 = *very much*)) [a]	
		(Do you think that washing hands with soap and water is time-consuming? (0 = *not at all* to 4 = *very much*)) [a]	
		(Do you think that washing hands with soap and water takes a lot of effort? (0 = *not at all* to 4 = *very much*)) [a]	
		(Do you think that the hand washing facility is far away from your usual area of activity? (0 = *not at all* to 4 = *very much*)) [b]	
	Nurture[c]	Do you think that you risk the health of your children if you don't wash your hands with soap and water? (0 = *not risk their health at all* to 4 = *risk their health very much*)	.57
		Do you wash your hands with soap and water because you wish to set a good example for the children? (0 = *not at all* to 4 = *very much*)	
	Affective beliefs	How much do you like or dislike washing hands with soap and water? (−4 = *I dislike it very much* to 4 = *I like it very much*)	.76
		How pleasant or unpleasant do you think it is to wash hands with soap and water? (−4 = *very much unpleasant* to 4 = *very much pleasant*)	

(continued)

Table A-2 (continued). Item wording of the social-cognitive factors and Cronbach's alphas, Ethiopia

Factor groups	Construct	Items	α
	Disgust, stool-related[d]	Do you feel dirty if you don't wash your hands with soap and water after defecation? (0 = *don't feel dirty* to 4 = *feel very dirty*)	–
	Disgust, food-related[d]	Do you think it is disgusting not to wash hands with soap and water before handling food? (0 = *not disgusting* to 4 = *very disgusting*)	–
Norm factors	Norms, stool-related	How many people in your family wash hands with water and soap after contact with stool? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	.72
		How many people in your community wash hands with water and soap after contact with stool? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	
		People who are important to you, do they rather approve or disapprove if you wash your hands with soap and water after contact with stool? (−4 = *nearly all disapprove* to 4 = *nearly all approve*)	
		People who are important to you, do they rather think you should or you should not wash your hands with soap and water after contact with stool? (−4 = *nearly all think I should not* to 4 = *nearly all think I should*)	
	Norms, food-related	How many people in your family wash hands with water and soap before handling food? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	.73
		How many people in your community wash hands with water and soap before handling food? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	
		People who are important to you, do they rather approve or disapprove if you wash your hands with soap and water before handling food? (−4 = *nearly all disapprove* to 4 = *nearly all approve*)	
		People who are important to you, do they rather think you should or you should not wash your hands with soap and water before handling food? (−4 = *nearly all think I should not* to 4 = *nearly all think I should*)	
Ability factors	Motivational self-efficacy, stool-related	Do you think you are able to always wash hands with soap and water after contact with stool? (0 = *not able* to 4 = *very able*)	–
	Motivational self-efficacy, food-related	Do you think you are able to always wash hands with soap and water before handling food? (0 = *not able* to 4 = *very able*)	–

(continued)

Table A-2 (continued). Item wording of the social-cognitive factors and Cronbach's alphas, Ethiopia

Factor groups	Construct	Items	α
	Volitional self-efficacy	How confident are you that you can wash hands with soap and water…	.87
		…even if you have to walk some distance to reach the next handwashing facility? (0 = *not confident* to 4 = *very confident*)	
		…even if urgent tasks arise which interfere with handwashing? (0 = *not confident* to 4 = *very confident*)	
		…even if you do not feel like handwashing? (0 = *not confident* to 4 = *very confident*)	
		Imagine you have stopped washing hands with soap and water for several days, e.g. because you didn't have water for hand washing. How confident are you to start washing hands with soap and water again? (0 = *not confident* to 4 = *very confident*)	
	Impediments	When you think about...	.75
		... the last 24 hours: How often did it happen that you intended to wash hands with soap and water but were hindered in doing so? (*natural numbers*)	
		... the last week: How often did it happen that there was no water for hand washing? (*natural numbers*)	
		... the last week: How often did it happen that there was no soap for hand washing? (*natural numbers*)	
Self-regulation factors	Coping planning	Do you have a detailed plan...	n/a
		…what to do when there is no water for hand washing? (0 = *no detailed plan* to 4 = *very detailed plan*)	
		…what to do when there is no soap for hand washing? (0 = *no detailed plan* to 4 = *very detailed plan*)	
		…how to avoid forgetting to wash hands with soap and water? (0 = *no detailed plan* to 4 = *very detailed plan*)	
	Forgetting	When you think about... the last 24 hours: How often did it happen that you intended to wash hands with soap and water and then forgot to do so? (*natural numbers*)	–
	Commitment, stool-related	Do you feel committed to washing hands with soap and water after contact with stool? (0 = *not committed* to 4 = *very committed*)	–
	Commitment, food-related	Do you feel committed to washing hands with soap before handling food? (0 = *not committed* to 4 = *very committed*)	–

Note. n/a = not applicable: items are that diverse in content that a common variance is not expected and thus Cronbach's alphas are not applicable. Still, the items were combined to scales due to theoretical reasons. [a] Items had to be excluded due to zero variance. [b] Item had to be excluded as handwashing facilities were non-existent. [c&d] Nurture and disgust were not combined into larger scales, to allow for examining their unique explanatory power.

Appendix II: Additional information for Part Three

Results from linear regression and mediation analyses for social-cognitive factors

Table A-3. Linear regression analysis for social-cognitive factors explaining SRH

Factor groups	Social-cognitive factors	*B*	SE *B*	*p*	CI (95%) for *B*
	Constant	2.39	0.17	.000	[2.05, 2.73]
Risk factors	Perceived vulnerability	0.00	0.01	.730	[-0.02, 0.01]
	Perceived cholera severity	0.00	0.02	.980	[-0.04., 0.03]
	Health knowledge	**-0.10**	**0.05**	**.038**	**[-0.19, -0.01]**
Attitude factors	Instrumental beliefs				
	Efforts	-0.02	0.02	.328	[-0.07, 0.02]
	Response efficacy	**0.06**	**0.02**	**.014**	**[0.01, 0.10]**
	Attractiveness	-0.02	0.01	.060	[-0.03, 0.00]
	Nurture: Teaching and caring	0.03	0.02	.141	[-0.01, 0.08]
	Return	**0.03**	**0.01**	**.005**	**[0.01, 0.05]**
	Affective beliefs				
	Liking and pleasantness	-0.04	0.03	.117	[-0.10, 0.01]
	Soap attributes: Smell	**0.06**	**0.01**	**.000**	**[0.03, 0.09]**
	Disgust	**0.05**	**0.02**	**.001**	**[-0.02, 0.08]**
	Attitude towards cholera patients	0.00	0.01	.611	[-0.02, 0.01]
Norm factors	Descriptive norms				
	Family	0.00	0.03	.919	[-0.05, 0.05]
	Community	**0.04**	**0.01**	**.005**	**[0.01, 0.07]**
	Injunctive norm	0.02	0.02	.204	[-0.01, 0.06]
	Personal norm	0.01	0.02	.669	[-0.03, 0.05]
	Compliance mobilizers	0.01	0.01	.219	[-0.01, 0.03]
Ability factors	**Motivational self-efficacy**	**0.12**	**0.04**	**.002**	**[0.04, 0.19]**
	Recovery self-efficacy	0.04	0.03	.241	[-0.03, 0.10]
	Impediments				
	General impediments	**-0.06**	**0.02**	**.003**	**[-0.10, -0.02]**
	HW-station out of order	0.00	0.02	.944	[-0.04, 0.04]
	No water or no soap	-0.04	0.02	.029	[-0.08, 0.00]
Self-regulation factors	Forgetting	-0.03	0.02	.129	[-0.06, 0.01]
	Coping planning: Detailed plan	**0.12**	**0.02**	**.000**	**[0.07, 0.17]**

Note. N = 745. Adjusted R^2 = .45. CI = Confidence interval. Factors in bold are significantly related with SRH and were selected for subsequent mediation analysis.

Table A-4. Mediation results: Effects of social-cognitive factors on SRH

Factor groups	Social-cognitive factors	*B*	SE *B*	*p*
Risk factors	Health knowledge	-0.13	0.05	.008
Attitude factors	Return	0.03	0.01	.001
	Response efficacy	0.06	0.02	.022
	Smell of soap	0.05	0.01	.000
	Disgust	0.04	0.02	.005
Norm factors	Descriptive norm community	0.04	0.01	.003
Ability factors	Motivational self-efficacy	0.18	0.03	.000
	General impediments	-0.09	0.02	.000
Self-regulation factors	Coping planning: Detailed plan	0.14	0.02	.000

Note. N = 653. Adjusted R^2 = .48.

Table A-5. Linear regression analysis for social-cognitive factors explaining FRH

Factor groups	Social-cognitive factors	*B*	SE *B*	*p*	CI (95%) for *B*
	Constant	1.09	0.22	.000	[0.65, 1.52]
Risk factors	Perceived vulnerability	-0.01	0.01	.446	[-0.03, 0.01]
	Perceived cholera severity	**0.06**	**0.02**	**.006**	**[0.02, 0.10]**
	Health knowledge	0.02	0.06	.787	[-0.10, 0.13]
Attitude factors	Instrumental beliefs				
	Efforts	-0.01	0.03	.678	[-0.07, 0.05]
	Response efficacy	0.04	0.03	.162	[-0.02, 0.10]
	Attractiveness	**0.03**	**0.01**	**.007**	**[0.01, 0.05]**
	Nurture: Teaching and caring	0.04	0.03	.188	[-0.02, 0.09]
	Return	0.02	0.01	.055	[0.00, 0.05]
	Affective beliefs				
	Liking and pleasantness	0.04	0.03	.199	[-0.02, 0.11]
	Soap attributes: Smell	**0.05**	**0.01**	**.007**	**[0.01, 0.08]**
	Disgust	0.03	0.02	.078	[0.00, 0.06]
	Attitude towards cholera patients	***-0.02***	***0.01***	***.041***	***[-0.04, 0.00]***
Norm factors	Descriptive norms				
	Family	**0.09**	**0.03**	**.004**	**[0.03, 0.15]**
	Community	0.02	0.02	.210	[-0.01, 0.06]
	Injunctive norm	**0.09**	**0.02**	**.000**	**[0.04, 0.13]**
	* Personal norm				
	Compliance mobilizers	0.02	0.01	114	[-0.01, 0.04]
Ability factors	**Motivational self-efficacy**	**0.12**	**0.04**	**.007**	**[0.03, 0.21]**
	Recovery self-efficacy	0.01	0.04	.821	[-0.07, 0.09]
	Impediments				
	General impediments	**-0.14**	**0.03**	**.000**	**[-0.19, -0.09]**
	HW-station out of order	***0.06***	***0.03***	***.031***	***[0.01, 0.11]***
	No water or no soap	***-0.09***	***0.03***	***.001***	***[-0.14, -0.04]***
Self-regulation factors	**Forgetting**	**-0.10**	**0.02**	**.000**	**[-0.14, -0.05]**
	Coping planning: Detailed plan	**0.16**	**0.03**	**.000**	**[0.10, 0.22]**

Note. N = 748. Adjusted R^2 = .61. CI = Confidence interval. Factors in bold are significantly related with FRH and were selected for subsequent mediation analysis. Factors in italic are significantly related with FRH but had to be excluded from mediation analysis. * Factor had to be excluded due to high multicollinearity.

Table A-6. Mediation results: Effects of social-cognitive factors on FRH

Factor groups	Social-cognitive factors	*B*	SE *B*	*p*
Risk factors	Perceived cholera severity	0.08	0.02	.000
Attitude factors	Attractiveness	0.02	0.01	.039
	Smell of soap	0.03	0.02	.038
Norm factors	Descriptive norm family	0.13	0.03	.000
	Injunctive norm	0.09	0.02	.000
Ability factors	Motivational self-efficacy	0.13	0.04	.000
	General impediments	-0.17	0.02	.000
Self-regulation factors	Forgetting	-0.14	0.02	.000
	Coping planning: Detailed plan	0.20	0.03	.000

Note. $N = 701$. Adjusted $R^2 = .63$.

Appendix III: Additional information for Part Four

Social-cognitive factors' measurement – Chapter I

Detailed interventions' descriptions – Chapters I & II

Maintenance planning file – Chapter I

Means and standard deviations at baseline, follow-up, and changes over time by intervention group – Chapter II

Table A-7. Operationalization of social-cognitive factors

Factor groups	Construct	Items	*α*	*M*	*SD*
Risk factors	Vulnerability	How high do you feel is the risk that you will get diarrhoea? (0 = *no risk* to 4 = *high risk*)	.89	0.33	0.33
		How high do you feel is the risk that the child under the age of 5 in your household will get diarrhoea? (0 = *no risk* to 4 = *high risk*)			
	Severity	Imagine that you contracted diarrhoea. How severe would the impact be on…	.76	0.91	0.12
		… your life in general? (0 = *not severe* to 4 = *very severe*)			
		… your social life? (0 = *not severe* to 4 = *very severe*)			
		… your economic situation? (0 = *not severe* to 4 = *very severe*)			
		Imagine that the child under the age of 5 contracted diarrhea how severe would that be? (0 = *not severe* to 4 = *very severe*)			
	Health-knowledge	Can you tell me what causes diarrhoea?	.68	0.25	0.11
		What are the effects of diarrhoea on your body?			
		Can you tell me how you can prevent getting diarrhoea?			
		(Open question format. Answers were scored according to correctness. 0 = *no knowledge* to 4 = *maximal knowledge score*).			
Attitude factors	Response-efficacy	How certain are you that washing hands with soap and water after contact with stool and before handling food prevents you and your family from getting diarrhoea? (0 = *not certain* to 4 = *very certain*)	−	0.83	0.17
	Attractiveness	Do you feel more attractive when you wash your hands with soap and water? (0 = *not at all more attractive* to 4 = *much more attractive*)	−	0.86	0.16
	Nurture	Do you think that you risk the health of your children if you don't wash your hands with soap and water? (0 = *not risk their health at all* to 4 = *risk their health very much*)	.57	0.79	0.17
		Do you wash your hands with soap and water because you wish to set a good example for the children? (0 = *not at all* to 4 = *very much*)			

(continued)

Table A-7 (continued). Operationalization of social-cognitive factors

Factor groups	Construct	Items	α	M	SD
	Affective beliefs	How much do you like or dislike washing hands with soap and water? (−4 = *I dislike it very much* to 4 = *I like it very much*)	.76	0.91	0.15
		How pleasant or unpleasant do you think it is to wash hands with soap and water? (−4 = *very much unpleasant* to 4 = *very much pleasant*)			
		How much do you like or dislike the smell of your hands after washing hands with soap and water? (−4 = *I dislike it very much* to 4 = *I like it very much*)			
	Disgust, stool-related	Do you feel dirty if you don't wash your hands with soap and water after defecation? (0 = *don't feel dirty* to 4 = *feel very dirty*)	−	0.82	0.23
	Disgust, food-related	Do you think it is disgusting not to wash hands with soap and water before handling food? (0 = *not disgusting* to 4 = *very disgusting*)	−	0.82	0.18
Norm factors	Descriptive-norm – stool-related	How many people in your community wash hands with water and soap after contact with stool? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	−	0.63	0.20
	– food-related	How many people in your community wash hands with water and soap before handling food? (0 = *(almost) nobody* to 4 = *(almost) all of them*)	−	0.65	0.20
	Injunctive-norm – stool-related	People who are important to you, do they rather approve or disapprove if you wash your hands with soap and water after contact with stool? (−4 = *nearly all disapprove* to 4 = *nearly all approve*)	.78	0.71	0.31
		People who are important to you, do they rather think you should or you should not wash your hands with soap and water after contact with stool? (−4 = *nearly all think I should not* to 4 = *nearly all think I should*)			
	– food-related	People who are important to you, do they rather approve or disapprove if you wash your hands with soap and water before handling food? (−4 = *nearly all disapprove* to 4 = *nearly all approve*)	.75	0.72	0.29
		People who are important to you, do they rather think you should or you should not wash your hands with soap and water before handling food? (−4 = *nearly all think I should not* to 4 = *nearly all think I should*)			
Ability factors	Action-knowledge	Can you show me how you usually wash your hands? (Washing both hands with soap = 2 points; cleaning under nails = 1 point; air drying or with a clean towel = 1 point)	−	0.69	0.23

(continued)

Table A-7 (continued). **Operationalization of social-cognitive factors**

Factor groups	Construct	Items	*α*	*M*	*SD*
	Motivational self-efficacy – stool-related	Do you think you are able to always wash hands with soap and water after contact with stool? (0 = *not able* to 4 = *very able*)	–	0.75	0.21
	– food-related	Do you think you are able to always wash hands with soap and water before handling food? (0 = *not able* to 4 = *very able*)	–	0.75	0.21
	Volitional self-efficacy	How confident are you that you can wash hands with soap and water… …even if you have to walk some distance to reach the next handwashing facility? (0 = *not confident* to 4 = *very confident*) …even if urgent tasks arise which interfere with handwashing? (0 = *not confident* to 4 = *very confident*) …even if you do not feel like handwashing? (0 = *not confident* to 4 = *very confident*) Imagine you have stopped washing hands with soap and water for several days, e.g. because you didn't have water for hand washing. How confident are you that you will start washing hands with soap and water again? (0 = *not confident* to 4 = *very confident*)	.77	0.60	0.28
	Impediments[a]	When you think about... ... the last 24 hours: How often did it happen that you intended to wash hands with soap and water but were hindered in doing so? (*natural numbers*) ... the last week: How often did it happen that there was no water for hand washing? (*natural numbers*) ... the last week: How often did it happen that there was no soap for hand washing? (*natural numbers*)	.75	1.04	1.33
Self-regulation factors	Action-control	How aware were you of your goal to wash hands with soap and water? (0 = *not aware* to 4 = *very aware*) How strongly did you try to wash hands with soap and water? (0 = *not at all* to 4 = *very much*)	.52	0.75	0.16
	Action-planning	Do you have a specific place and facility for handwashing? 0 = *no*; 1 = *yes*)	–	8%[b]	–
	Coping-planning – water	Do you have a detailed plan what to do when there is no water for hand washing? (0 = *no detailed plan* to 4 = *very detailed plan*)	–	0.22	0.30
	Coping-planning – soap	Do you have a detailed plan what to do when there is no soap for hand washing? (0 = *no detailed plan* to 4 = *very detailed plan*)	–	0.31	0.38
	Coping-planning – forgetting	Do you have a detailed plan how to avoid forgetting to wash hands with soap and water? (0 = *no detailed plan* to 4 = *very detailed plan*)	–	0.04	0.14

(continued)

Table A-7 (continued). Operationalization of social-cognitive factors

Factor groups	Construct	Items	*α*	*M*	*SD*
	Forgetting[a]	When you think about the last 24 hours: How often did it happen that you intended to wash hands with soap and water and then forgot to do so? (*natural numbers*)	–	0.73	1.39
	Commitment-strength – stool-related	Do you feel committed to washing hands with soap and water after contact with stool? (0 = *not committed* to 4 = *very committed*)	–	0.77	0.20
	– food-related	Do you feel committed to washing hands with soap before handling food? (0 = *not committed* to 4 = *very committed*)	–	0.78	0.19

[a] Answer scales are reverse coded; that is, higher mean values represent higher improvement potential. [b] For this dichotomous item, the percentage of people having a specific place and facility for handwashing is presented.

Detailed interventions' descriptions

Educational intervention: f-diagram exercise

As an educational intervention, an f-diagram exercise was implemented. The f-diagram is a graph, illustrating the transmission routes of diarrhoea, which is regularly used by NGOs as a hygiene behaviour change tool (David et al., 2009; Global WASH Cluster, 2011). In the present study, the f-diagram tool was applied in an interactive learning setting by means of a group-sorting task at a community meeting. The community meetings lasted for approximately one hour.

At the meeting, after a short introduction, the participants were split into smaller groups of six to seven people. Each group received a set of eight picture cards representing the f-diagram and each was asked to try to put the pictures into ordered sequences according to the transmission of diarrheal disease. After task completion, each group explained their story of transmission and misunderstandings were clarified. Subsequently groups were invited to draw pictures or symbols of barriers to transmission and to place these at key points in the story. These prevention methods were then presented and discussed in plenum. After, six pictures showing handwashing as barrier to transmission were handed out to the groups, which were asked to place these cards at the appropriate junctions in the story. This was again discussed in the assembled group. The route of contamination and its prevention methods were repeated and remaining questions answered before closing the community meeting.

Public-commitment intervention

In line with previous research (Inauen & Mosler, 2013) community meetings were organized at which primary caregivers that had agreed during home visits to publicly commit participated and gave an oral statement of their commitment. At the community meeting, first the education intervention, which was implemented as part of the commitment meeting in intervention arms with public commitment, was delivered as outlined above. After, the group was informed that now the public commitment would take place. In a first step, all primary caregivers who were willing to commit were asked to raise their hands. Then, each primary caregiver willing to commit was asked to rise individually, commit aloud to always wash hands with soap at key times in order to prevent their family from diarrhoea, and then to sign a commitment certificate by signature or finger-mark. Right after, the committed primary caregiver received the certificate and a headscarf. The participants were asked to wear the headscarf as a sign of their commitment and to hang up the certificate in their home. The community meetings lasted for approximately two hours, including

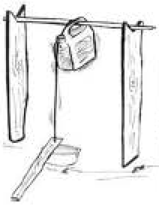
Infrastructure-promotion intervention

The handwashing station, which was selected for promotion, is the tippy tap. The tippy tap is a low-cost technology constructed out of locally available materials (i.e. branches and a jerry can), that means replacement parts can easily be organized (tippytap.org, n.d.). It uses only 40 millilitres of water for handwashing, versus 500 millilitres using a mug, which is the traditional handwashing technique used in the Borena zone. The acceptance and applicability of the tippy tap in the Borena zone was pre-tested in one of the study kebeles, whereby the local NGO constructed a tippy tap in the presence of the community, and its members were invited to try it out. The community's reaction was very positive.

Households were invited and motivated during home visits to construct a tippy tap themselves. This approach was preferred over simple provision of a handwashing station, to enhance the commitment to use the facility. They were informed of the materials they would need to obtain for the construction (four branches of wood, rope, a nail, digging tools, a knife, a candle, and gravel), and that the local NGO would contribute a jerry can. If the households agreed to the construction, they were supported in selecting the most convenient place for the tippy tap. A community meeting was held during which the construction was explained through demonstration and where every participating household received a jerry can to be used for the tippy tap. The community meetings lasted for approximately one hour followed by a 30-minute construction session during which each household constructed the tippy tap with the promoters' assistance.

Because a functional handwashing station implies continuous presence of water and soap, an additional intervention was implemented in half of the households in the educ+infr and educ+pub+infr conditions intended to tackle a continuous provision of water and soap at the handwashing station, the maintenance-planning intervention. During home visits primary caregivers were motivated to establish a daily routine regarding to fill water and when to check if soap has to be replaced which was recorded in a planning file to pin up at home.

Maintenance planning file



When during day do you refill the water?

☐ Early morning: 0 to 3 | ☐ Morning: 3 to 6 | ☐ Early afternoon: 6 to 9 | ☐ Afternoon: 9 to 12 | ☐ Evening: 0 to 3

After doing what? | Before doing what? | After doing what? | Before doing what? | After doing what? | Before doing what?

☐  ☐

☐  ☐

☐  ☐

☐  ☐

☐  ☐

☐  ☐

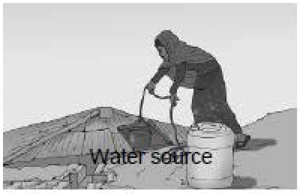
☐  ☐

☐  ☐

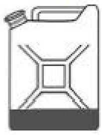
☐  ☐

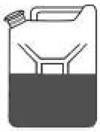
Where do you take the water from?

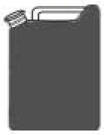
☐ 

☐ 

How much water do you refill?

☐ 

☐ 

☐ 

What day do you check if you have to replace soap?

☐ Monday | ☐ Tuesday | ☐ Wednesday | ☐ Thursday

☐ Friday | ☐ Saturday | ☐ Sunday

☐ Early morning: 0 to 3 | ☐ Morning: 3 to 6 | ☐ Early afternoon: 6 to 9 | ☐ Afternoon: 9 to 12 | ☐ Evening: 0 to 3

Where do you take the soap from?

☐ 

☐ 

Table A-8. Means and standard deviations at baseline, follow-up, and changes over time by intervention group

	Handwashing		Descriptive norm		Injunctive norm		Motivational self-efficacy	
Time x group	Stool	Food	Stool	Food	Stool	Food	Stool	Food
Baseline								
Educ	0.82 (0.22)	0.76 (0.25)	0.71 (0.23)	0.71 (0.22)	0.75 (0.27)	0.75 (0.24)	0.76 (0.29)	0.76 (0.23)
Educ + pub	0.84 (0.21)	0.79 (0.20)	0.67 (0.19)	0.70 (0.19)	0.78 (0.25)	0.79 (0.23)	0.78 (0.17)	0.79 (0.18)
Educ + infr	0.78 (0.25)	0.74 (0.24)	0.63 (0.21)	0.63 (0.20)	0.70 (0.36)	0.72 (0.30)	0.76 (0.21)	0.76 (0.21)
Educ + pub + infr	0.72 (0.26)	0.65 (0.22)	0.57 (0.18)	0.59 (0.19)	0.69 (0.27)	0.65 (0.32)	0.71 (0.23)	0.70 (0.22)
Follow-up								
Educ	0.63 (0.29)	0.54 (0.26)	0.52 (0.21)	0.69 (0.31)	0.53 (0.29)	0.72 (0.23)	0.76 (0.23)	0.74 (0.23)
Educ + pub	0.74 (0.24)	0.64 (0.23)	0.66 (0.23)	0.82 (0.19)	0.65 (0.22)	0.83 (0.15)	0.83 (0.18)	0.80 (0.24)
Educ + infr	0.80 (0.25)	0.73 (0.24)	0.67 (0.20)	0.85 (0.18)	0.68 (0.21)	0.88 (0.16)	0.87 (0.16)	0.85 (0.20)
Educ + pub + infr	0.80 (0.24)	0.74 (0.23)	0.69 (0.20)	0.84 (0.19)	0.67 (0.19)	0.84 (0.19)	0.86 (0.18)	0.82 (0.22)
Change								
Educ	-0.19 (0.37)	-0.23 (0.34)	-0.18 (0.28)	-0.17 (0.36)	-0.06 (0.33)	-0.03 (0.31)	0.00 (0.36)	-0.02 (0.28)
Educ + pub	-0.10 (0.29)	-0.15 (0.27)	-0.01 (0.27)	-0.06 (0.28)	0.05 (0.30)	0.05 (0.26)	0.05 (0.24)	0.01 (0.30)
Educ + infr	0.01 (0.33)	-0.02 (0.34)	0.04 (0.29)	0.05 (0.29)	0.16 (0.38)	0.16 (0.34)	0.11 (0.26)	0.09 (0.29)
Educ + pub + infr	0.08 (0.33)	0.09 (0.31)	0.12 (0.27)	0.08 (0.27)	0.15 (0.34)	0.19 (0.36)	0.15 (0.27)	0.12 (0.30)

(continued)

Table A-8 (continued). Means and standard deviations at baseline, follow-up, and changes over time by intervention group

Time x group	Volitional self-efficacy	Impediments[a]	Forgetting[a]	Commitment strength	
				Stool	Food
Baseline					
Educ	0.54 (0.35)	1.41 (1.39)	0.48 (1.04)	0.73 (0.18)	0.77 (0.17)
Educ + pub	0.63 (0.29)	0.69 (1.14)	0.39 (0.87)	0.81 (0.18)	0.80 (0.17)
Educ + infr	0.60 (0.27)	1.08 (1.38)	0.77 (1.47)	0.76 (0.20)	0.77 (0.18)
Educ + pub + infr	0.56 (0.27)	1.24 (1.22)	1.02 (1.72)	0.73 (0.22)	0.77 (0.22)
Follow-up					
Educ	0.72 (0.25)	2.80 (2.00)	1.91 (1.93)	0.82 (0.20)	0.73 (0.21)
Educ + pub	0.79 (0.19)	2.22 (1.90)	1.56 (2.03)	0.86 (0.16)	0.80 (0.18)
Educ + infr	0.88 (0.14)	1.15 (1.54)	0.73 (1.41)	0.90 (0.15)	0.87 (0.17)
Educ + pub + infr	0.88 (0.15)	1.57 (1.92)	0.98 (1.68)	0.90 (0.15)	0.86 (0.17)
Change[b]					
Educ	0.18 (0.38)	1.39 (2.12)	1.43 (1.85)	0.09 (0.23)	-0.04 (0.29)
Educ + pub	0.16 (0.33)	1.53 (2.23)	1.17 (2.15)	0.05 (0.22)	0.01 (0.22)
Educ + infr	0.28 (0.29)	0.07 (2.00)	-0.02 (1.90)	0.14 (0.24)	0.10 (0.25)
Educ + pub + infr	0.32(0.32)	0.33 (2.04)	-0.04 (2.47)	0.16 (0.28)	0.09 (0.26)

Note. n = 23 (Educ); n = 122 (Educ+pub). n = 150 (Educ+infr). n = 113 (Educ+pub+infr). Educ = Education; pub = public commitment; infr = infrastructure-promotion. Scales ranged from 0 to 1 (unipolar items) or from -1 to 1 (bipolar items) except for [a] that ranged from 0 to infinite. [b] Individual baseline values were subtracted from follow-up values.

Curriculum vitae

Nadja Contzen

Born 6 March 1982 in Zug, Switzerland

nadja.contzen@gmail.com

Academic training

Mar 2011 – Sep 2014	Eawag, the Swiss Federal Institute of Aquatic Science & Technology, and University of Zurich *PhD studies*
Aug 2014	Swiss Summer School, Lugano, Switzerland *Course: Multilevel analysis*
Aug 2014	CREATE Workshop, Innsbruck, Austria *Course: Leveraging mobile technology and social media in behavioral research*
Aug 2012	Swiss Summer School, Lugano, Switzerland *Course: Introduction to panel data analysis*
Oct 2002 – Apr 2009	University of Zurich, University of Berne and Humboldt University of Berlin *Studies at the Faculty of Arts: Major in Social Psychology and minor subjects of Political Science and Mass Communication and Media Research*

Degrees

2009	Master of Science Thesis title “EU – Friend or Enemy? National Identity and Euroscepticism in Switzerland”

Professional experience

2011 – present	Eawag, Department of Environmental Social Sciences *Research fellow*
2009 – 2011	University of Zurich, Department of Psychology *Research fellow*
2008	Eawag, Department of System Analysis, Integrated Assessment and Modelling *Internship*
2005 – 2006 / 2008	University of Zurich, Department of Psychology *Tutorial assistant*
2006 – 2009	eurelations AG *Project assistant (administration of medical research projects under the European framework program)*

Projects

2014 – present	Safe Water Enterprise Evaluation Project in Kenya *Evaluation of safe drinking water kiosks established by Siemens Foundation in Kenya*
2014	Improving hygiene behaviour through population-tailored interventions in Haiti and Mali *Consultancy for Helvetas Haiti and Mali to improve their hygiene interventions aimed at increasing sanitation uptake and handwashing. Training and guidance in planning and conducting baseline research for population-tailored interventions.*
2012 – 2013	Hygiene promotion behaviour change research: a longitudinal study of Oxfam hygiene promotions on hand-washing behavior in the 2011-2012 drought response in southern Ethiopia *Design and evaluation of interventions promoting handwashing*
2011	Factors determining the effectiveness of Oxfam's cholera response and public health promotion in different regions of Haiti *Evaluation of interventions promoting handwashing*

Project co-acquisition

2014	Safe Water Enterprise Evaluation Project in Kenya *Evaluation of safe drinking water kiosks established by Siemens Foundation in Kenya*

Teaching

Autumn 2010	Identität und Einstellung gegenüber Fremdgruppen (Identity and attitudes towards out-groups) *Seminar, Department of Psychology, University of Zurich*
Spring 2010	Stereotype und Vorurteile (Stereotypes and prejudice) *Seminar, Department of Psychology, University of Zurich*
2009-2010	Projektgruppe "Vorurteils- und Identitätsforschung" (project group "prejudice and identity research") *Project group, Department of Psychology, University of Zurich*
Autumn 2009	Identität und Einstellung gegenüber Fremdgruppen (Identity and attitudes towards out-groups) *Seminar, Department of Psychology, University of Zurich*
Spring 2008	Tutorial in social psychology *Tutorial, Department of Psychology, University of Zurich*

Memberships

European Health Psychology Society
Deutsche Gesellschaft für Psychologie

Voluntary work

2006 – 2007	Co-organisation of the psyko'07 – Swiss national congress of psychology students

Publications

Peer-reviewed	Contzen, N., Meili, I. H., & Mosler, H.-J. (2015). Changing handwashing behaviour in southern Ethiopia: A longitudinal study on infrastructural and commitment interventions. *Social Science & Medicine, 124*, 103-114. doi: 10.1016/j.socscimed.2014.11.006
	Contzen, N., & Mosler, H.-J. (2013). Impact of different promotional channels on handwashing behaviour in an emergency context: Haiti post-earthquake public health promotions and cholera response. *Journal of Public Health, 21*(6), 559-573. doi: 10.1007/s10389-013-0577-4
In progress	Contzen, N., & Mosler, H.-J. (2014). *Identifying the psychological determinants of handwashing: Results from two cross-sectional questionnaire studies in Haiti and Ethiopia.* Manuscript submitted for publication.
	Contzen, N., & Inauen, J. (2014). *Social cognitive factors mediating intervention effects on handwashing: A longitudinal study.* Manuscript submitted for publication.
	Contzen, N., De Pasquale, S., & Mosler, H-J. (2014). *Over-reporting in handwashing self-reports: identifying explanatory factors and mitigating measures.* Manuscript submitted for publication.
Other publications	Contzen, N., & Mosler H.-J. (2013). Handwashing behavior change: infrastructural and commitment interventions in the Borena Zone, Ethiopia. *Working Papers in Environmental Social Sciences 2013-07,* Department of Environmental Social Sciences, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Dübendorf, Switzerland.
	Contzen, N., & Mosler H.-J. (2012). Factors determining the effectiveness of Oxfam's public health promotion approach in Haiti. *Working Papers in Environmental Social Sciences 2012-00,* Department of Environmental Social Sciences, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Dübendorf, Switzerland.
Oral presentations	Contzen, N., & Inauen, J. (2014). *Social cognitive factors mediating intervention effects on handwashing: A longitudinal study.* Oral presentation at the 28th Conference of the European Health Psychology Society, Innsbruck, Austria.
	Contzen, N., Meili, I., & Mosler, H.-J. (2013). *How to change handwashing behavior: infrastructural and commitment interventions in the Borena Zone, Ethiopia.* Oral presentation at the 2013 Water and Health Conference: Where Science Meets Policy. Chapel Hill, USA.
	Contzen, N., & Mosler, H.-J. (2012). *Behaviour Change in Emergency Contexts: Handwashing Promotion in Post-Earthquake Haiti and Drought Response in Borena Zone, Ethiopia.* Oral presentation at the Fifth Emergency Environmental Health Forum, London, UK.
	Contzen, N., & Mosler, H.-J. (2012). *Behavior change in an emergency context: Haiti post-earthquake public health promotions and cholera response.* Oral presentation at the International Water Safety Conference, Kampala, Uganda.
	Contzen, N., & Mosler, H.-J. (2012). *Determining the effectiveness of public health promotion approaches to the earthquake in Haiti.* Oral presentation at the 26th Conference of the European Health Psychology Society, Prague, Czech Republic.
	Contzen, N., & Jonas, K. (2010). *"We asked for workers but human beings came" – prejudice and discrimination against Muslims in Switzerland.* Oral presentation at the 33rd Annual Scientific Meeting of the International Society of Political Psychology, San Francisco, USA.

Contzen, N., & Jonas, K. (2009). *EU – Freund oder Feind? Nationale Identität und Euroskeptizismus in der Schweiz.* Mündliche Präsentation an der 12. Tagung der Fachgruppe Sozialpsychologie, Walferdange, Luxemburg.

Contzen, N., & Jonas, K. (2009). *EU – Friend or enemy? National identity and euroscepticism in Switzerland.* Oral presentation at the 11th Congress of the Swiss Psychological Society, Neuchâtel, Switzerland

Poster presentations

Contzen, N., Meili, I., & Mosler, H.-J. (2013). *Changing handwashing behavior in southern Ethiopia: a longitudinal study on infrastructural and commitment interventions.* Poster presented at the 27th Conference of the European Health Psychology Society, Bordeaux, France.

Contzen, N., & Mosler, H.-J. (2012). *Behaviour Change in Emergency Contexts: Handwashing Promotion in Post-Earthquake Haiti and Drought Response in Borena Zone, Ethiopia.* Poster presentation at the Fifth Emergency Environmental Health Forum, London, UK.

Contzen, N., & Mosler, H.-J. (2012). *Behavior Change in emergency contexts: handwashing promotion in post-earthquake Haiti and drought response in Borena Zone, Ethiopia.* Poster presented at the 2012 Water and Health Conference: Science, Policy and Innovation, Chapel Hill, USA.

Contzen, N., & Mosler, H.-J. (2012). *Factors determining the effectiveness of public health promotion approaches to the earthquake and cholera outbreak in Haiti.* Poster presented at the 3rd International Conference on Research for Development, Bern, Switzerland.